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(54) IMAGING LENS DEVICE AND DIGITAL CAMERA EQUIPPED WITH IMAGING LENS DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a completely new imaging lens device, equipped with a zoom lens system, which is small-sized and has high power and high

picture quality.

SOLUTION: An imaging lens system (TL) is a zoom lens. A 1st optical axis (AX1) is bent by 90° by a 1st reflecting member (REF1). On a 2nd optical axis (AX2) bent by the 1st reflecting member (REF1), a 1st moving lens group (MVL1) and an aperture stop (SP) are arranged. The 2nd optical axis (AX2) is bent by 90° by a 2nd reflecting member (REF2) in a plane perpendicular to the 1st optical axis. On a 3rd optical axis (AX3) bent by the 2nd reflecting member (REF2), a 2nd moving lens gruop (MVL2) is arranged. When the imaging lens system zooms, the positions of the 1st reflecting member (REF1), aperture stop (SP), and 2nd reflecting member (REF2) are fixed and while the 1st moving lens group moves on the 2nd optical axis, the 2nd moving lens group moves on the 3rd optical axis.

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CLAIMS

[Claim(s)]

[Claim 1]

The zoom lens system which performs variable power by consisting of two or more groups and changing group spacing,

The image sensor which changes into an electrical signal the optical image formed of the zoom lens system,

It is preparation ****** lens equipment,

A zoom lens system is in the order from a body side.

The 1st reflector, the 1st migration lens group, the 2nd reflector, and the 2nd

migration lens group are included,

An incident light shaft is bent by the 1st reflector 90 degrees of abbreviation, and an optical axis is further bent by the 2nd reflector,

In zooming,

The 1st reflector and 2nd reflector are image pick-up lens equipment which is location immobilization and is characterized by the 1st migration lens group and the 2nd migration lens group moving in an optical-axis top.

[Claim 2]

Said 1st migration lens group is image pick-up lens equipment according to claim 1 characterized by having negative optical power and said 2nd migration lens group having forward optical power.

[Claim 3]

The zoom lens system which performs variable power by consisting of two or more groups and changing group spacing,

The image sensor which changes into an electrical signal the optical image formed of the zoom lens system,

It is preparation ****** lens equipment,

A zoom lens system is in the order from a body side,

The 1st reflector, a diaphragm, and the 2nd reflector are included,

An incident light shaft is bent by the 1st reflector 90 degrees of abbreviation, and an optical axis is further bent by the 2nd reflector,

When the 1st reflector, a diaphragm, and the 2nd reflector are location immobilization and the focal distance of the zoom lens system in D2 and a wide angle edge is set to fw for the distance of a diaphragm and the 2nd reflector in zooming,

$$0.3 < D2 / fw < 3$$

Image pick-up lens equipment characterized by being satisfied.

[Claim 4]

It has the 1st migration lens group which has the negative optical power arranged between said 1st reflector and said 2nd reflector, and the 2nd migration lens group which has the forward optical power arranged from said 2nd reflector at the image side,

Said 1st reflector is image pick-up lens equipment according to claim 3 characterized by being contained in the group which has forward optical power.

[Claim 5]

It is image pick-up lens equipment according to claim 1 or 3,

Image pick-up lens equipment characterized by satisfying the following conditional expression.

$2< |fa1 / fw| <8$

It corrects,

fa1: It is the focal distance of the group by the side of a body from the 1st reflector,

fw: The focal distance of the zoom lens system in a wide angle edge,

It comes out.

[Claim 6]

Image pick-up lens equipment according to claim 1 or 4 characterized by performing focusing by migration of said 2nd migration group.

[Claim 7]

The digital camera equipped with image pick-up lens equipment according to claim 1 to 6.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to image pick-up lens equipment equipped with the suitable zoom lens system for digital-input/output devices, such as a digital camera and a digital camcorder, which is compact and has a rate of high variable power in more detail about image pick-up lens equipment. Moreover, it

is related with the digital camera equipped with such image pick-up lens equipment.

[0002]

[Description of the Prior Art]

In recent years, a digital still camera, a digital camcorder, etc. which can incorporate image information to a digital instrument easily are spreading on individual user level with the spread of personal computers etc. (a digital camera is called below). It is expected that such a digital camera continues to spread increasingly as an input device of image information.

[0003]

By the way, generally the image quality of a digital camera is determined with the number of pixels of solid state image sensors, such as CCD (Charge Coupled Device). High pixel-ization exceeding 1 million pixels is made, and current and the digital camera for general tend to approach the film-based camera in respect of image quality. Since to perform variable power of an image, especially optical variable power with little image degradation is also desired also in these digital cameras for general, it is small and recent years require increasingly the zoom lens for digital cameras with which are satisfied of the rate of high variable power,

and high definition.

[0004]

About a miniaturization, optical system is bent by inserting prism or a reflective mirror between lenses, and the miniaturization of the direction of an optical axis is promoted further. The single focal lens which bent the optical axis once is indicated by the patent reference 1. Moreover, the single focal lens which bent the optical axis twice is indicated by the patent reference 2.

[0005]

[Patent reference 1] JP,6-107070,A

[Patent reference 2] The Europe patent 0906587BNo. 1 specification

[Problem(s) to be Solved by the Invention]

However, although the optical system indicated by the patent reference 1 and the patent reference 2 is attaining the miniaturization by bending an optical path, it is a single focal lens and is not the zoom lens which is satisfied with the rate of high variable power of high definition. In the zoom lens of the about 5-time rate of high variable power, since the movement magnitude of a movable group is also large, an overall length becomes large, and it is not avoided that the body of a camera is enlarged [many / lens number of sheets]. Moreover, if it is going to

make the overall length of optical system small by force, increase of error sensibility will be caused and a manufacture error will influence optical-character ability greatly. Moreover, when the movable group in a zoom is made [many] and an optical overall length is miniaturized, a camera cone configuration will become complicated and the body of a camera will be enlarged. furthermore, high definition -- high -- since a scale factor strangely zoom lens is miniaturized, in order to bend an optical path, it is necessary to take into consideration arrangement and the camera cone configuration of a migration group

[0006]

In view of the above problem, this invention is small and aims at offering image pick-up lens equipment equipped with the completely new zoom lens system which satisfies the rate of high variable power, and high definition. Moreover, the digital camera equipped with such image pick-up lens equipment is offered.

[0007]

[Means for Solving the Problem]

In order to attain the above-mentioned purpose, the image pick-up lens equipment of the 1st invention The zoom lens system which performs variable power by consisting of two or more groups and changing group spacing, It is

image pick-up lens equipment equipped with the image sensor which changes into an electrical signal the optical image formed of the zoom lens system. A zoom lens system The 1st reflector, the 1st migration lens group, the 2nd reflector, and the 2nd migration lens group are included sequentially from a body side. An incident light shaft The 1st reflector bends 90 degrees of abbreviation, an optical axis is further bent by the 2nd reflector, in zooming, the 1st reflector and 2nd reflector are location immobilization, and the 1st migration lens group and the 2nd migration lens group move in an optical-axis top.

[0008]

The image pick-up lens equipment of the 2nd invention has optical power negative in said 1st migration group in the configuration of invention of the above 1st, and said 2nd migration group has forward optical power.

[0009]

The zoom lens system which performs variable power by the image pick-up lens equipment of the 3rd invention consisting of two or more groups, and changing group spacing, It is image pick-up lens equipment equipped with the image sensor which changes into an electrical signal the optical image formed of the zoom lens system. A zoom lens system The 1st reflector, a diaphragm, and the

2nd reflector are included sequentially from a body side. An incident light shaft The 1st reflector bends 90 degrees of abbreviation, an optical axis is further bent by the 2nd reflector, and the 1st reflector, a diaphragm, and the 2nd reflector are location immobilization in zooming. When setting the focal distance of the zoom lens system in D2 and a wide angle edge to fw for the distance of a diaphragm and the 2nd reflector,

$0.3 < D2 / fw < 3$

It is satisfied.

[0010]

The 1st migration lens group which has the negative optical power by which the image pick-up lens equipment of the 4th invention has been arranged between said 1st reflector and said 2nd reflector in the configuration of invention of the above 3rd, It has the 2nd migration lens group which has the forward optical power arranged from said 2nd reflector at the image side, and said 1st reflector is included in the group which has forward optical power.

[0011]

The image pick-up lens equipment of the 5th invention is image pick-up lens equipment characterized by satisfying the following conditional expression in the

configuration of the above 1st or the 3rd invention.

$2<|fa1 / fw|<8$

It corrects,

fa1: It is the focal distance of the group by the side of a body from the 1st reflector,

fw: The focal distance of the zoom lens system in a wide angle edge,

It comes out.

[0012]

As for the image pick-up lens equipment of the 6th invention, focusing is performed by migration of said 2nd migration group in the configuration of the above 1st or the 4th invention.

[0013]

Moreover, the 7th invention is the digital camera equipped with the image pick-up lens equipment which has the above 1st thru/or the 6th one of the configurations of invention.

[0014]

[Embodiment of the Invention]

Hereafter, the image pick-up lens equipment which carried out this invention is

explained, referring to a drawing. the camera with which the image pick-up lens equipment which incorporates the image of a photographic subject optically and is outputted as an electric signal is used for still picture photography and animation photography of a photographic subject -- {-- for example, it is the main component of built-in or camera} by which external is carried out at a digital camera; video camera; digital video unit, a personal computer, a mobile computer, a cellular phone, an information personal digital assistant (PDA), etc.

[0015]

Drawing 14 is the outline external view of the digital camera concerning this invention, drawing 14 (a) is the front view of a digital camera, and drawing 14 (b) is the rear view of a digital camera. a digital camera 1 -- the liquid crystal display monitor (LCD) 4 and the manual operation button 5 are arranged [image pick-up lens equipment 6] for the release carbon button 3 by the tooth back in the front face at the top face.

[0016]

Drawing 1 is drawing showing the outline of the internal configuration of a digital camera, drawing 1 (a) corresponds to the front view of a digital camera, and drawing 1 (b) corresponds to the side elevation of image pick-up lens equipment.

A photographic subject is located in space left-hand side in a space near side and drawing 1 (b) in drawing 1 (a). In drawing 1 , the line shown with a two-dot chain line expresses the case 2 of the digital camera which has image pick-up lens equipment 6. the image pick-up lens equipment 6 comes out sequentially from a body (photographic subject) side with the taking-lens system (TL) which forms an objective optical image, the plane-parallel plate (LPF) equivalent to an optical low pass filter etc., and the image sensor (SR) which changes into an electric signal the optical image formed of the taking-lens system (TL), and is constituted.

[0017]

Solid state image sensors which consist, for example of two or more pixels as an image sensor (SR), such as CCD and a CMOS (Complementary Metal Oxide Semiconductor) sensor, are used, and the optical image formed of the image pick-up lens system (TL) is changed into an electric signal. Moreover, when the optical image which should be formed by the image pick-up lens system (TL) passes the optical low pass filter (LPF) which has the predetermined cut-off frequency property determined with the pixel pitch of an image sensor (SR), spatial frequency characteristics are adjusted so that the so-called clinch noise

generated in case it is changed into an electric signal may be minimized.

[0018]

Predetermined analog image processing, digital image processing, picture compression processing, etc. are performed, it is recorded on memory 8 (semiconductor memory, optical disk, etc.) as a digital video signal, a cable is minded depending on the case, or the signal generated with the image sensor (SR) is changed into an infrared signal by the signal-processing section 7, and is transmitted to other devices. A controller 10 consists of a microcomputer and controls intensively the lens migration device for a photography function, an image reconstruction function or zooming, and focusing etc. A liquid crystal display monitor 4 displays as an image the picture signal changed by the image sensor (SR), or displays as an image the picture signal recorded on memory 8. A control unit 9 includes the various dials of the release carbon button 3 and manual operation button 5 grade, and a carbon button, and the information by which an actuation input is carried out is transmitted to a controller 10 by the user through a control unit 9.

[0019]

Next, an image pick-up lens system (TL) is explained using drawing 1 . An image

pick-up lens system (TL) is a zoom lens system. The 90 degrees (AX1) of the 1st optical axis which is an incident light shaft are bent by the 1st reflective member (REF1). On the 2nd optical axis (AX2) which bent by the 1st reflective member (REF1), it extracts as the 1st migration lens group (MVL1), and (SP) is stationed. The 90 degrees (AX2) of the 2nd optical axis are bent by the 2nd reflective member (REF2) in the direction still more nearly perpendicular to the 1st optical axis. On the 3rd optical axis (AX3) which bent by the 2nd reflective member (REF2), the 2nd migration lens group (MVL2) is arranged. The 1st optical axis (AX1), 2nd optical axis (AX2), and 3rd optical axis (AX3) are mutually perpendicular. In zooming of an image pick-up lens system (TL), it extracts as the 1st reflective member (REF1), and (SP) and the 2nd reflective member (REF2) are location immobilization, the 1st migration lens group (MVL1) moves in a 2nd optical-axis top, and the 2nd migration lens group (MVL2) moves in a 3rd optical-axis top. Migration of these migration lens groups is controlled by the controller 10.

[0020]

A digital camera 1 serves as thin shape-ization miniaturizable with the image pick-up lens equipment 6 of the above-mentioned explanation. -izing can be

carried out [thin shape] to incident light shaft orientations by bending the 90 degrees (AX1) of the 1st optical axis, and bending the 2nd optical axis in the perpendicular direction to the 1st optical axis. Moreover, by bending the 2nd optical axis (AX2), even if it is a high scale-factor zoom lens with a long overall length, it becomes miniaturizable. In addition, although I hope that the 3rd optical axis (AX3) in an image pick-up lens system (TL) is not perpendicular to the 2nd optical axis (AX2), it is desirable for the 2nd and 3rd optical axis to be in a flat surface perpendicular to the 1st optical axis. With constituting such,-izing can be carried out [thin shape] to incident light shaft orientations. Moreover, the 1st optical axis (AX1) and 3rd optical axis (AX3) may be parallel, and the 1st and 3rd opticals axis and 2nd opticals axis may be perpendicular. In this case, breadth of a digital camera can be small made thin.

[0021]

Drawing 2 - drawing 5 are the lens block diagrams corresponding to the zoom lens system which constitutes the gestalt of the 1st - the 4th operation of the above-mentioned image pick-up lens equipment, respectively, and show lens arrangement in a wide angle edge (W) in the optical cross section. The arrow head mj (j= 1, 2, ...) in each lens block diagram shows typically migration of the

j-th group (Grj) in zooming from a wide angle edge (W) to a tele edge (T) etc., respectively, and the arrow head mF shows the migration direction of the focal group in focusing to the contiguity from infinite distance. Moreover, among each lens block diagram, the field where ri (i= 1, 2 and 3, ...) was attached is counted from a body side, and is the i-th field, and the field where * mark was given to ri is the aspheric surface. Axial top-face spacing to which di (i= 1, 2 and 3, ...) was given is variable spacing which counts from a body side and changes in zooming among the i-th axial top-face spacing. In addition, for convenience, an optical axis is not bent but, as for each lens block diagram of drawing 2 - drawing 5 , the lens is arranged on the straight line. Therefore, the configuration and the reflective mirror REF2 of a rectangular prism REF1 for bending are not illustrated.

[0022]

Each zoom lens system of each operation gestalt has the 2nd lens group which has negative power, (Gr2) and the 3rd lens group (Gr3) which has forward power, and the 4th lens group (Gr4) which has forward power sequentially from a body side. [the 1st lens group (Gr1) which has forward power,] At the time of the variable power from a wide angle edge [W] to a tele edge [T], the 2nd lens group (Gr2) moves so that it may always be located in an image surface side

rather than the location in a wide angle edge [W] (BARIETA), and the 4th lens group moves so that the image point migration accompanying migration of the 2nd lens group may be amended (compensator), and it has the composition of performing variable power, by changing spacing of each lens group.

[0023]

And the glass plane-parallel plate (LPF) equivalent to an optical low pass filter etc. is arranged at the image surface side as a zoom lens system used for the camera (for example, digital still camera) equipped with the solid state image sensor (for example, CCD). Also in the gestalt of which operation, the 1st lens group (Gr1) consists of lenses containing the rectangular prism (REF1) for bending at least one negative lens and an optical axis sequentially from a body side, and two positive lenses. Moreover, the cemented lens is used for the 2nd lens group (Gr2) and the 3rd lens group (Gr3). The lens configuration of the gestalt of each operation is explained below in more detail. In addition, the plane-parallel plate of drawing 2 - drawing 5 arranged most at the image surface side is cover glass of an image sensor (SR).

[0024]

<< -- gestalt (drawing 2 , forward negative-positive-positive negative)>> of the

1st operation -- the zoom lens systems of the gestalt of the 1st operation are forward and a negative one, and forward, forward, and negative 5 group zoom lens, and each lens group is constituted as follows sequentially from the body side. the 1st lens group (Gr1) comes out with the positive meniscus lens (abbreviation plano-convex lens) of a convex, and is constituted at the negative meniscus lens [of concave], rectangular-prism [which is the 1st reflective member for bending 90 degrees of opticals axis] REF1 (in drawing 2 , it displays with parallel plate), positive lens [of both convexes], and body side at the image surface side. the 2nd lens group (Gr2) comes out with the negative lens which has the double-sided aspheric surface, and the cemented lens which changes from the negative lens of both concaves, and the positive lens of both convexes to a body side, is constituted, and is arranged on the 2nd optical axis (AX2). the 3rd lens group (Gr3) comes out with the cemented lens which extracts and changes from the negative meniscus lens of concave to a (SP), positive lens [of both convexes], positive lens [of both convexes], and body side, and is constituted. The reflective mirror REF2 (not shown) is arranged between the positive lens of both convexes, and a cemented lens (d16). the 4th lens group (Gr4) has the aspheric surface in a body side, appears in a body side with the

negative meniscus lens of a convex, and the positive lens of both convexes, is constituted, and is arranged on the 3rd optical axis (AX3). The 5th lens group (Gr5) has the double-sided aspheric surface, and consists of negative meniscus lenses of concave at the body side.

[0025]

<< -- gestalt (drawing 3 , forward negative-positive-positive forward)>> of the 2nd operation -- the zoom lens systems of the gestalt of the 2nd operation are forward and a negative one, and forward, forward, and forward 5 group zoom lens, and each lens group is constituted as follows sequentially from the body side. the 1st lens group (Gr1) comes out with the positive meniscus lens of a convex, and is constituted at the negative meniscus lens [of concave], rectangular-prism [which is the 1st reflective member for bending 90 degrees of opticals axis] REF1 (in drawing 3 , it displays with parallel plate), positive lens [of both convexes], and body side at the image surface side. the 2nd lens group (Gr2) comes out with the cemented lens which consists of the negative lens which has the double-sided aspheric surface, the negative lens of both concaves, and the positive lens of both convexes, is constituted, and is arranged on the 2nd optical axis (AX2). the 3rd lens group (Gr3) comes out with the cemented

lens which extracts and changes from the negative meniscus lens of concave to a (SP), positive lens [of both convexes], positive lens [of both convexes], and body side, and is constituted. The reflective mirror REF2 (not shown) is arranged between the positive lens of both convexes, and a cemented lens (d16). the 4th lens group (Gr4) has the aspheric surface in a body side, comes out with the positive meniscus lens of a convex, is constituted at the negative meniscus lens [of a convex], and body side at the body side, and is arranged on the 3rd optical axis (AX3). The 5th lens group (Gr5) has the double-sided aspheric surface, and consists of positive meniscus lenses of concave at the body side.

[0026]

<< -- gestalt (drawing 4 , forward negative-positive-positive)>> of the 3rd operation -- the zoom lens systems of the gestalt of the 3rd operation are forward and negative, forward, and forward 4 group zoom lens, and each lens group is constituted as follows sequentially from the body side. the 1st lens group (Gr1) comes out with the positive meniscus lens of a convex, and is constituted at the negative meniscus lens [of concave], rectangular-prism [which is the 1st reflective member for bending 90 degrees of opticals axis] REF1 (in drawing 4 , it displays with parallel plate), positive lens [of both

convexes], and body side at the image surface side. the 2nd lens group (Gr2) comes out with the negative lens which has the double-sided aspheric surface, and the cemented lens which consists of the positive meniscus lens of a convex at a body side at a negative meniscus lens [of concave], and image surface side, is constituted, and is arranged on the 2nd optical axis (AX2). the 3rd lens group (Gr3) comes out with the forward meniscus lens (abbreviation plano-convex lens) which extracts and has a convex in a body side with (SP), and the cemented lens which changes from the negative lens of both concaves to a positive lens [of both convexes], and body side, and is constituted. The reflective mirror REF2 (not shown) is arranged between a positive lens and a cemented lens (d16). the 4th lens group (Gr4) has the aspheric surface in a body side, appears in a body side with the negative meniscus lens of a convex, and the positive lens of both convexes, is constituted, and is arranged on the 3rd optical axis (AX3).

[0027]

<< -- gestalt (drawing 5 , forward negative-positive-positive forward)>> of the 4th operation -- the zoom lens systems of the gestalt of the 4th operation are forward and a negative one, and forward, forward, and forward 5 group zoom

lens, and each lens group is constituted as follows sequentially from the body side. the 1st lens group (Gr1) appears in an image surface side with the negative meniscus lens of concave, the rectangular prism REF1 (in drawing 5 , it displays with an parallel plate) which is the 1st reflective member for bending 90 degrees of opticals axis, the positive lens of both convexes, and the positive lens of both convexes, and is constituted. the 2nd lens group (Gr2) comes out with the cemented lens which consists of the negative lens which has the double-sided aspheric surface, the negative lens of both concaves, and the positive lens of both convexes, is constituted, and is arranged on the 2nd optical axis (AX2). the 3rd lens group (Gr3) comes out with the cemented lens which extracts and consists of (SP), the positive lens of both convexes, the positive lens of both convexes, and the negative lens of both concaves, and is constituted. The reflective mirror REF2 (not shown) is arranged at the image side (d19) of a cemented lens. the 4th lens group (Gr4) has the aspheric surface in a body side, appears in a body side with the negative meniscus lens of a convex, and the positive lens of both convexes, is constituted, and is arranged on the 3rd optical axis (AX3). The 5th lens group (Gr5) has the double-sided aspheric surface, and consists of positive meniscus lenses of a convex at the body side.

[0028]

With the gestalt of the above 1st, the 2nd, and the 4th operation At the time of the variable power from a wide angle edge [W] to a tele edge [T], the location of the 1st lens group (Gr1), the 3rd lens group (Gr3), and the 5th lens group (Gr5) is immobilization. It moves in a 2nd optical-axis top so that the 2nd lens group (Gr2) may always be located in an image surface side rather than the location in a wide angle edge [W], and the 4th lens group (Gr4) makes a U-turn to an image surface side, after moving a 3rd optical-axis top to a body side.

[0029]

With the gestalt of implementation of the above 3rd, the location of the 1st lens group (Gr1) and the 3rd lens group (Gr3) is immobilization at the time of the variable power from a wide angle edge [W] to a tele edge [T]. It moves in a 2nd optical-axis top so that the 2nd lens group (Gr2) may always be located in an image surface side rather than the location in a wide angle edge [W], and the 4th lens group (Gr4) makes a U-turn to an image surface side, after moving a 3rd optical-axis top to a body side.

[0030]

Variable power is performed because the 2nd lens group (Gr2) moves in a 2nd

optical-axis (AX2) top and the 4th lens group (Gr4) moves also in the gestalt of which operation like the above-mentioned explanation in a 3rd optical-axis (AX3) top. It is arranged on the optical axis with which each migration groups differ, and since each migration device can constitute independently, a simple and small camera cone configuration is attained.

[0031]

Moreover, the 1st lens group (Gr1) in which body light carries out incidence including the 1st reflective member is location immobilization, for the inner zoom method with which (Gr2) moves [the 2nd lens group] in a 2nd optical-axis top, and the 4th lens group (Gr4) moves in a 3rd optical-axis top, it does not have the elutriation of a lens in zooming and photography of it is possible in the flat camera always condition.

[0032]

As for a zoom lens system, it is desirable to fill the conditional expression shown below. Thereby, the zoom lens system of a high scale factor excellent in compactability is realizable. In addition, although it is possible to attain the operation effectiveness corresponding to it if each conditions of explaining below are fulfilled independently, respectively, it cannot be overemphasized that it is

more more desirable from viewpoints, such as optical-character ability and a miniaturization, to fulfill two or more conditions.

[0033]

It is desirable to satisfy the following conditional expression (1).

$0.3 < D2 / fw < 3$ (1)

It corrects,

D2: Distance of a diaphragm and the reflector of the 2nd reflective member,

fw: The focal distance of the zoom lens system in a wide angle edge,

It comes out.

Conditional expression (1) is conditions which specify the distance of a diaphragm and the 2nd reflector. Since the distance of a diaphragm and the 2nd reflector will become large too much if the upper limit of conditional expression (1) is exceeded, a reflective member is not desirable in respect of becoming large and calling it a miniaturization. A clinch becomes difficult in order that the distance of a diaphragm and the 2nd reflector may approach too much, if less than the lower limit of conditional expression (1).

[0034]

Conditional expression (1) is .

0.8 -- < -- D2 / fw <2.5 (1) '

It comes out and a certain thing is more desirable. By conditional-expression (1) ', while being able to miniaturize the 2nd reflective member more, the interference conditions of a diaphragm and the 2nd reflector are eased, a more nearly free lens configuration is attained, and aberration amendment becomes easy.

[0035]

Moreover, it is desirable to satisfy the following conditional expression (2).

2<|fa1 / fw|<8 (2)

It corrects,

fa1: It is the focal distance of the group by the side of a body from the 1st reflector,

fw: The focal distance in a wide angle edge,

It comes out.

Conditional expression (2) is conditions which specify the focal distance of the group by the side of a body from the 1st reflector. Since the focal distance (absolute value) of the group by the side of a body will become small too much from the 1st reflector if less than the lower limit of conditional expression (2), distortion aberration, especially the negative distortion aberration by the side of a

wide angle become remarkable, and it becomes difficult to secure good optical-character ability. Conversely, if the upper limit of conditional expression (2) is exceeded, the focal distance (absolute value) of the group by the side of a body will become large too much from the 1st reflector. Consequently, enlargement of the lens system of the 1st group and a reflective member is caused, and it is not desirable in respect of miniaturization.

[0036]

Conditional expression (2) is ,

$4<|fa1/fw|<6.5$ (2) '

It comes out, and a certain thing is more desirable and becomes compatible [better optical-character ability and miniaturization] by doing so.

[0037]

Moreover, since it is desirable to perform focusing by the smallest possible group of lens weight, the small 4th lens group (Gr4) of the diameter of a lens with little lens number of sheets as a focal group is desirable.

[0038]

Moreover, like the gestalt of each operation, it is desirable to arrange the aspheric surface in the 2nd lens group (Gr2), and curvature-of-field aberration

can be amended good by arranging the aspheric surface in the 2nd lens group (Gr2). Moreover, like the gestalt of each operation, it is desirable to arrange the aspheric surface in the 4th lens group (Gr4), and various aberration, such as curvature-of-field aberration and spherical aberration, can be amended good by arranging the aspheric surface in the 4th lens group (Gr4). Furthermore, it is desirable to arrange the aspheric surface in the 5th lens group (Gr5), and curvature-of-field aberration can be further amended good by arranging the aspheric surface in the 5th lens group (Gr5)..

[0039]

In addition, although each lens group which constitutes the gestalt of the 1st - the 4th operation consists of only refraction mold lenses (that is, lens of the type with which a deviation is performed by the interface of the media which have a different refractive index) which deflect an incident ray by refraction, it is not restricted to this. For example, each lens group may consist of a diffraction mold lens which deflects an incident ray by diffraction, a refraction / diffraction hybrid mold lens which deflects an incident ray in the combination of a diffraction operation and a refraction operation, a gradient index lens which deflects an incident ray according to the refractive-index distribution in a medium.

[0040]

Furthermore, although the gestalt of each operation showed the example of a configuration of the optical low pass filter of the plane-parallel-plate configuration arranged between the last side of a zoom lens system, and an image sensor, a birefringence mold low pass filter made from Xtal with which the predetermined crystal orientation was adjusted as this low pass filter, the phase mold low pass filter which attains the property of optical cut-off frequency needed according to the diffraction effect are applicable.

[0041]

[Example]

Construction data etc. are mentioned and the configuration of the zoom lens system hereafter used for the image pick-up lens equipment which carried out this invention etc. is explained still more concretely. In addition, the next examples 1-4 are equivalent to the gestalt of the 1st - the 4th operation mentioned above, respectively, and the lens block diagram (drawing 2 - drawing 5) showing the gestalt of the 1st - the 4th operation shows the lens configuration of the corresponding examples 1-4, respectively.

[0042]

In the construction data of each example, ri (i= 1, 2 and 3, ...) is counted from a body side. The radius of curvature of the i-th field, Count di (i= 1, 2 and 3, ...) from a body side, and the i-th axial top-face spacing is shown. nickel (i= 1, 2 and 3, ...) and vi (i= 1, 2 and 3, ...) are counted from a body side, and show the refractive index (Nd) and the Abbe number (vd) to d line of the i-th optical element, respectively. Moreover, axial top-face spacing which changes in zooming is adjustable air spacing in a wide angle edge (short focus distance edge) [W] middle (middle focal distance condition) [M] - a tele edge (long focal distance edge) [T] among construction data. The focal distance (f) and the f number (FNO) of the whole system corresponding to each focal distance condition [W], [M], and [T] are shown collectively, and the value corresponding to conditional expression is shown in Table 1. Moreover, the movement magnitude (focal data) of the 4th lens group (Gr4) in focusing at the time of contiguity photography is shown in Table 2. In examples 1-3, it is D= 0.37m in photography distance (object point - image point) of a contiguity photography condition, and an example 4 is D= 0.67m in photography distance (object point - image point) of a contiguity photography condition.

[0043]

It shall be shown that the field where * mark was given to radius of curvature ri is a field which consisted of the aspheric surfaces, and it shall define as the formula (AS) of the following showing the field configuration of the aspheric surface. The aspheric surface data of each aspheric surface are combined with other data, and are shown.

X(H) =(C-H2)/{1+root (1-epsilon-C 2, H2)} + (A4, H4+A6, H6+A8 and H8+A10, H10) (AS)

However, inside of a formula (AS),

X (H) : The amount of displacement of the direction of an optical axis in the location of height H (plane peak point criteria),

H : it is the height of a perpendicular direction to an optical axis,

C : paraxial curvature,

epsilon : secondary curved-surface parameter,

Ai : i-th aspheric surface multiplier,

It comes out.

[0044]

<u>Drawing 6</u> - <u>drawing 13</u> are the aberration Figs. corresponding to an example 1 - an example 4, respectively, and the aberration Fig. in the infinite distance

photography condition respectively corresponding to an example 1 - an example 4 in drawing 6 - drawing 9 , drawing 10 - drawing 13 are the aberration Figs. in the contiguity photography condition corresponding to an example 1 - an example 4, respectively. In examples 1-3, it is D= 0.37m in photography distance (object point - image point) of a contiguity photography condition, and an example 4 is D= 0.67m in photography distance (object point - image point) of a contiguity photography condition. [W] is the inside of drawing 6 - drawing 13 , and many aberration [in / a wide angle edge and [M], and / in [T] / a tele edge] (sequentially from the left, they are astigmatism and distortion aberration, such as spherical aberration.). [middle] Y': The maximum image quantity is shown. In the spherical-aberration Fig., spherical aberration [as opposed to d line in a continuous line (d)], spherical aberration [as opposed to g line in an alternate long and short dash line (g)], spherical aberration [as opposed to c line in a two-dot chain line (c)], and a broken line (SC) express sine condition. In the astigmatism Fig., the astigmatism over d line in a meridional side is expressed, and, as for the broken line (DM), the continuous line (DS) expresses the astigmatism over d line in a sagittal side. Moreover, in the distortion aberration Fig., the continuous line expresses distortion % to d line.

[0051]

In addition, with the gestalt of the 1st - the 4th operation, although a rectangular prism is used for the 1st reflective member and the reflective mirror is used for the 2nd reflective member, a reflective member is not restricted to this. For example, a reflective mirror may be used for the 1st reflective member, prism may be used for the 2nd reflective member, and a front surface mirror or a rear-face mirror is sufficient as a reflective mirror. Moreover, a reflective member

may have optical power in a reflector, and may be a reflective mold diffraction component.

[0052]

Moreover, the configuration of each digital camera 1 corresponding to the image pick-up lens equipment of the gestalt of the 1st - the 4th operation is the same as the configuration shown by drawing 1 , and it is same in addition to image pick-up lens equipment.

[0053]

[Effect of the Invention]

The image pick-up lens equipment which attained the miniaturization of a zoom lens system and high variable power-ization is realizable, satisfying high definition according to this invention, as explained above. Since especially the image pick-up lens equipment of this invention bent the optical axis for the incident light shaft 90 degrees of abbreviation according to the 1st reflector and the optical axis is further bent according to the 2nd reflector, very compact image pick-up lens equipment is realizable.

[0054]

Moreover, in zooming, the 1st reflector, a diaphragm, and the 2nd reflector are

location immobilization, since the image pick-up lens equipment of this invention moves the 1st migration lens group arranged between the 1st reflector and the 2nd reflector, and the 2nd migration lens group arranged at the image side of the 2nd reflector, it can simplify a camera cone configuration and miniaturization and low cost-ization of it are attained. Moreover, a lens does not jump out during photography for an inner zoom method.

[0055]

Furthermore, the above-mentioned image pick-up lens equipment can be applied to a digital camera, a video camera, and other electronic equipment (for example, a personal computer, a mobile computer, a cellular phone, an information personal digital assistant, etc.) at built-in or the camera by which external is carried out, and miniaturization (thin-shape-izing) of these devices, rate[of high variable power]-izing, and high definition-ization can be attained.

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the outline of the internal configuration of a digital camera.

[Drawing 2] It is the lens block diagram of the gestalt (example 1) of the 1st operation.

[Drawing 3] It is the lens block diagram of the gestalt (example 2) of the 2nd operation.

[Drawing 4] It is the lens block diagram of the gestalt (example 3) of the 3rd operation.

[Drawing 5] It is the lens block diagram of the gestalt (example 4) of the 4th operation.

[Drawing 6] It is an aberration Fig. in the infinite distance photography condition of an example 1.

[Drawing 7] It is an aberration Fig. in the infinite distance photography condition of an example 2.

[Drawing 8] It is an aberration Fig. in the infinite distance photography condition of an example 3.

[Drawing 9] It is an aberration Fig. in the infinite distance photography condition of an example 4.

[Drawing 10] It is an aberration Fig. in the contiguity photography condition (D= 0.37m) of an example 1.

[Drawing 11] It is an aberration Fig. in the contiguity photography condition (D= 0.37m) of an example 2.

[Drawing 12] It is an aberration Fig. in the contiguity photography condition (D= 0.37m) of an example 3.

[Drawing 13] It is an aberration Fig. in the contiguity photography condition (D= 0.67m) of an example 4.

[Drawing 14] It is the outline external view of the digital camera concerning this invention.

[Description of Notations]

TL Image pick-up lens system (zoom lens system)

SR Image sensor

LPF Low pass filter (plane-parallel plate)

AX1 The 1st optical axis (incident light shaft)

AX2 The 2nd optical axis

AX3 The 3rd optical axis

REF1 1st reflective member (rectangular prism)

REF2 2nd reflective member (reflective mirror)

MVL1 The 1st moving lens

MVL2 The 2nd moving lens

CVR Case of a camera

Gr1 The 1st lens group

Gr2 The 2nd lens group

SP Diaphragm

Gr3 The 3rd lens group

Gr4 The 4th lens group

Gr5 The 5th lens group

1 Digital Camera

2 Case

3 Release Carbon Button

4 Liquid Crystal Display Monitor (LCD)

5 Manual Operation Button

6 Image Pick-up Lens Equipment

7 Signal-Processing Section

8 Memory

9 Control Unit

10 Controller

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the outline of the internal configuration of a digital camera.

[Drawing 2] It is the lens block diagram of the gestalt (example 1) of the 1st operation.

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[Drawing 4] It is the lens block diagram of the gestalt (example 3) of the 3rd operation.

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[Drawing 8] It is an aberration Fig. in the infinite distance photography condition of an example 3.

[Drawing 9] It is an aberration Fig. in the infinite distance photography condition of an example 4.

[Drawing 10] It is an aberration Fig. in the contiguity photography condition (D= 0.37m) of an example 1.

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[Description of Notations]

TL Image pick-up lens system (zoom lens system)

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(54) IMAGING APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact imaging apparatus having a high performance and high magnifying power zoom lens system.
SOLUTION: The imaging apparatus is provided with a zoom lens system having a plurality of lens groups for continuously optically forming the optical image of an object so as to vary power by changing an interval between a plurality of the lens group and an

imaging device for converting the optical image formed by the zoom lens system to electric signals. The zoom lens system is provided with a first lens group having negative power as a whole and having a reflection surface for bending a luminous flux for about 90° and a second lens group arranged with a changeable air interval from the first lens group and having positive power in the order from an object side.

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]

It is image pick-up equipment equipped with the image sensor which changes into an electrical signal the optical image which the zoom lens system which forms an objective optical image possible [variable power] optically continuously, and the zoom lens system formed by having two or more lens groups and changing spacing of this plurality lens between groups,

Said zoom lens system is in the order from a body side,

The 1st lens group including the reflector which has negative power as a whole and bends the flux of light 90 degrees of abbreviation,

The 2nd lens group which separates air spacing which can change between said 1st lens groups, is arranged, and has forward power,

****** -- the image pick-up equipment characterized by things.

[Claim 2]

Image pick-up equipment according to claim 1 characterized by the 1st lens group of said zoom lens system consisting of the 1st lens element which has negative power, and a reflector sequentially from a body side.

[Claim 3]

Image pick-up equipment according to claim 1 with which the 1st lens group of said zoom lens system is characterized by consisting of the 1st lens element which has negative power and a reflector, and a lens element of at least one sheet sequentially from a body side.

[Claim 4]

Image pick-up equipment according to claim 1 to 3 with which the 1st lens group of said zoom lens system is characterized by being fixed to the image surface on the occasion of variable power.

[Claim 5]

Claim 1 thru/or 4 image pick-up equipment with which said zoom lens system is characterized by satisfying the following conditions :

$2 < |f1 / fw| < 4$

It corrects,

f1: The focal distance of the 1st lens group,

fw: The focal distance in the wide angle edge of the whole system,

It comes out.

[Claim 6]

Image pick-up equipment according to claim 1 to 5 most characterized by the field by the side of an image, and arranging [of said zoom lens system] the optical low pass filter between said image sensors.

[Claim 7]

The digital camera equipped with claim 1 thru/or one image pick-up equipment of 6.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs]

This invention The optical image formed on light-receiving sides, such as CCD (Charge Coupled Device charge-coupled device) and a CMOS sensor (Complementary Metal-oxide Semiconductor complementary metal oxide semiconductor sensor) It is related with image pick-up equipment equipped with the image sensor changed into an electrical signal. Especially, a digital camera; it is related with a personal computer, a mobile computer, a cellular phone, an information personal digital assistant (PDA:Personal Digital Assistance), etc. at

the image pick-up equipment which is the main component of built-in or the camera by which external is carried out. It is related with small image pick-up equipment equipped with the zoom lens system especially in detail.

[0002]

[Description of the Prior Art]

In recent years, image sensors, such as CCD and a CMOS sensor, are used instead of a silver halide film, an optical image is changed into an electrical signal, and the digital camera which digitizes, records or transmits the data is spreading quickly. In such a digital camera, in order to offer comparatively cheaply CCD which has high pixels, such as 2 million pixels and 3 million pixels, and a CMOS sensor recently, it is anxious for the compact image pick-up equipment with which the need over the highly efficient image pick-up equipment equipped with an image sensor is growing very much and which carried the zoom lens system in which variable power is possible, without getting down and degrading image quality especially.

[0003]

Furthermore, in recent years, by improvement in image-processing capacity, such as a semiconductor device, external is carried out and image pick-up

equipment is accelerating the personal computer, the mobile computer, the cellular phone, the information personal digital assistant (PDA:Personal Digital Assistance), etc. at built-in or the need over highly efficient image pick-up equipment.

[0004]

Many zoom lens systems of the so-called negative lead in which the lens group arranged most at the body side has negative power as a zoom lens system used for such image pick-up equipment are proposed. Wide-angle-izing is easy for the zoom lens system of a negative lead, and it has the description of being easy to secure the lens back required for insertion of an optical low pass filter.

[0005]

As a zoom lens system of a negative lead, there is a zoom lens system proposed as a taking-lens system of the camera for silver halide films from the former. However, since the exit pupil location of the lens system in the shortest focal distance condition was comparatively located near the image surface, especially these zoom lens systems did not have consistency with the pupil of the micro lens prepared corresponding to each pixel of the image sensor which has especially a high pixel, but had the problem that the amount of ambient light

could not fully secure. Moreover, since an exit pupil location was sharply changed at the time of variable power, the problem of being difficult also had a setup of the pupil of a micro lens. Moreover, primarily, with a silver halide film and an image sensor, since optical-character ability, such as spatial frequency characteristics called for, completely differed, sufficient optical-character ability required of an image sensor was not securable. For this reason, it will be necessary to develop the zoom lens system of the dedication optimized by image pick-up equipment equipped with the image sensor.

[0006]

On the other hand, since image pick-up equipment is miniaturized, the zoom lens system was bent in the middle of the optical path, and drawing or ****** has accomplished miniaturization, without changing the optical path length. For example, in the zoom lens system of a negative lead, after establishing a reflector on an optical path and bending 90 degrees of abbreviation, the image pick-up equipment which forms an optical image on an image sensor through a migration lens group is proposed by JP,11-196303,A. After the image pick-up equipment of this official report indication establishes a reflector in the image side of the fixed lens element of a negative meniscus configuration and bends

an optical path 90 degrees of abbreviation in this reflector, it has the configuration which results in an image sensor through two movable positive lens groups and the positive lens group of immobilization.

[0007]

Moreover, as another example, after establishing a reflector in the fixed lens element [of a negative meniscus configuration], and image side of a movable positive lens group and bending an optical path 90 degrees of abbreviation in this reflector, the configuration which results in an image sensor through a positive lens group is indicated by JP,11-258678,A.

[0008]

[Problem(s) to be Solved by the Invention]

However, in the two above-mentioned official reports, only the configuration of a camera cone was indicated but there was a problem that the configuration of a concrete zoom lens system was unknown. Unless the zoom lens system which occupies the biggest space in volume with image pick-up equipment equipped with the zoom lens system is optimized, it is difficult to attain the whole miniaturization.

[0009]

This invention aims at offering compact image pick-up equipment, it being highly efficient and having a high scale-factor zoom lens system in view of the above technical problem.

[0010]

[Means for Solving the Problem]

In order to solve the above-mentioned technical problem, the image pick-up equipment concerning this invention The zoom lens system which forms an objective optical image possible [variable power] optically continuously by having two or more lens groups and changing spacing of this plurality lens between groups, It is image pick-up equipment equipped with the image sensor which changes into an electrical signal the optical image which the zoom lens system formed. Said zoom lens system In order, it has negative power as a whole from a body side, and air spacing which can change between the 1st lens group including the reflector which bends the flux of light 90 degrees of abbreviation, and said 1st lens group is separated, and it is arranged, and is characterized by including the 2nd lens group which has forward power.

[0011]

Moreover, another side face of this invention is characterized by being a digital

camera containing the above-mentioned image pick-up equipment. In addition, conventionally, although the word of a digital camera had pointed out what records an optical still picture chiefly, the thing and the digital camcorder for home use which can treat an animation to coincidence are also proposed, and it is not distinguished especially now and is becoming. Therefore, the word of a digital camera shall contain hereafter all the cameras that use as a main component image pick-up equipment equipped with the image sensor which changes into an electrical signal the optical image formed on the light-receiving side of image sensors, such as a digital still camera and a digital movie.

[0012]

[Embodiment of the Invention]

Hereafter, 1 operation gestalt of this invention is explained with reference to a drawing.

[0013]

as shown in drawing 9 , the image pick-up equipment which is 1 operation gestalt of this invention comes out sequentially from a body side (photographic subject side) with the image sensor SR which changes into an electric signal the optical image formed of the zoom lens system which forms an objective optical

image possible [variable power], and TL, the optical low pass filter LPF and the zoom lens system TL, and is constituted. Moreover, the zoom lens system contains the 1st lens group Gr1 which has the prism PR which has a reflector inside, and the lens group which follows. Image pick-up equipment is the main component of built-in or the camera by which external is carried out at a digital camera; video camera; personal computer, a mobile computer, a cellular phone, an information personal digital assistant (PDA:Personal Digital Assistance), etc.

[0014]

The zoom lens system TL consists of two or more lens groups containing the 1st lens group Gr1, and it is possible by changing spacing between each lens group to change the magnitude of an optical image. The 1st lens group Gr1 has negative power, and has the prism PR which bends the optical axis of body light 90 degrees of abbreviation inside.

[0015]

The optical low pass filter LPF has the specific cut-off frequency for canceling the color moire which adjusts the spatial frequency characteristics of a taking-lens system, and is generated with an image sensor. The optical low pass filter of an operation gestalt is a birefringence mold low pass filter created by

carrying out the laminating of the wavelength plate to which birefringence ingredients and plane of polarization, such as Xtal adjusted in the predetermined direction in the crystallographic axis, are changed. In addition, the phase mold low pass filter which attains the property of required optical cut-off frequency according to the diffraction effect as an optical low pass filter may be adopted.

[0016]

An image sensor SR consists of CCD which has two or more pixels, and changes into an electrical signal the optical image which the zoom lens system formed by CCD. Predetermined digital image processing, picture compression processing, etc. are performed to the signal generated with the image sensor SR if needed, it is recorded on memory (semiconductor memory, optical disk, etc.) as a digital video signal, a cable is minded depending on the case, or it is changed into an infrared signal, and is transmitted to other devices. In addition, a CMOS sensor (Complementary Metal-oxide Semiconductor) may be used instead of CCD.

[0017]

Drawing 1 thru/or drawing 4 are the block diagrams showing lens arrangement in the shortest focal distance condition of the zoom lens system contained in the

image pick-up equipment of the 1st thru/or the 4th operation gestalt of this invention. In addition, in each drawing, the prism PR which has an internal reflection side is expressed with an parallel plate, and the optical path is expressed linearly.

[0018]

Monotonous PR by which the zoom lens system of the 1st operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the convex was turned on a body side, and prism in order from a body side to an image side, the 2nd lens element L2 of a negative meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side -- since -- with the 1st lens group Gr1 constituted The 2nd lens group Gr2 which consists of 1st cemented lens components DL 1 which come to join drawing ST, and the 4th lens element L4 of both the convex configuration and the 5th lens element L5 of both the concave configuration, the 4th lens group Gr4 which consists of 6th lens element L6 of a negative meniscus configuration which turned the concave surface to the body side, and the 7th lens group Gr5 which consists of the 7th lens element L7 of a negative meniscus configuration which

turned the concave surface to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0019]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. As the 1st lens group Gr1 moves to a body side once moving to an image side, the locus of the letter of U-turn of a convex is drawn, and it moves to an image side. The 2nd lens group Gr2 United with the diaphragm ST arranged at the body side of the 2nd lens group Gr2, it moves to a body side almost in monotone, and the 3rd lens group Gr3 moves to an image side almost in monotone, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0020]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 2nd lens element L2, the image side face of the 5th lens L5, and the body side face of 6th lens element L6.

[0021]

The 1st lens group Gr1 by which the zoom lens system of the 2nd operation

gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a body side to an image side, The 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, It extracts. since -- it has been arranged between the 2nd lens group Gr2 constituted, and this 2nd lens element L2 and the 3rd lens element L3 -- with ST the 3rd lens group Gr3 which consists of the 4th lens element L4 of both the convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the convex to the body side, and the 4th lens group Gr4 which consists of 6th lens element L6 of both the convex configuration -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0022]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed to the image surface, this zoom lens system is moved to a body side almost in monotone [the

2nd lens group Gr2], the 3rd lens group Gr3 moves to a body side almost in monotone united with Diaphragm ST, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0023]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the 2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0024]

The 1st lens group Gr1 by which the zoom lens system of the 3rd operation gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a body side to an image side, The 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, It extracts. since -- it has been arranged between the 2nd lens group Gr2 constituted, and this 2nd lens element L2 and the 3rd lens element L3 -- with ST the 3rd lens group Gr3 which consists of the 4th lens element L4 of both the

convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the concave surface to the body side, and the 4th lens group Gr4 which consists of 6th lens element L6 of both the convex configuration -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0025]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed for this zoom lens system to the image surface. The 2nd lens group Gr2 It extracts drawing the locus of a convex on a body side, and moves to a body side united with ST, and the 3rd lens group Gr3 moves to a body side almost in monotone, the 4th lens group Gr4 moves to an image side almost in monotone, and parallel monotonous LPF is being fixed to the image surface.

[0026]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. As the 1st lens group Gr1 moves to a body side once moving to an image side, the locus of the letter of U-turn of a

convex is drawn, and it moves to an image side. The 2nd lens group Gr2 United with the diaphragm ST arranged at the body side of the 2nd lens group Gr2, it moves to a body side almost in monotone, and the 3rd lens group Gr3 moves to an image side almost in monotone, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0027]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the 2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0028]

The 1st lens group Gr1 by which the zoom lens system of the 4th operation gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a body side to an image side, The 2nd lens group Gr2 which consists of the 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, Drawing ST and the 3rd lens group Gr3 which consists of the 3rd lens element L3 of a negative meniscus configuration which turned the convex to

the body side, the 5th lens group Gr5 which consists of a 4th lens group Gr4 which consists of the 4th lens element L4 of both the convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the convex to the body side, and 6th lens element L6 of a forward meniscus configuration which turned the convex to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 5th lens group Gr5 of this zoom lens system.

[0029]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed for this zoom lens system to the image surface. The 2nd lens group Gr2 It extracts drawing the locus of a convex on a body side, and moves to a body side united with ST, and the 3rd lens group Gr3 moves to a body side almost in monotone, the 4th lens group Gr4 moves to a body side almost in monotone, and the 5th lens group Gr5 is being fixed to the image surface with parallel monotonous LPF.

[0030]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the

2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0031]

The zoom lens system of each operation gestalt is equipped with Rhythm PR so that it may have the reflector which bends the optical axis of body light 90 degrees of abbreviation in the interior of the 1st group. Thus, it becomes possible by bending the optical axis of body light 90 degrees of abbreviation to attain thin shape-ization on the appearance of image pick-up equipment.

[0032]

When a digital camera is considered for an example, image pick-up equipment including a zoom lens system occupies the biggest volume in equipment. the zoom lens system by which the magnitude of the thickness direction of a camera is especially contained in image pick-up equipment like a film camera conventional with a digital camera lens shutter type when optical elements contained in a zoom lens system, such as a lens and a diaphragm, are arranged linearly, without changing the direction of an optical axis -- it is most determined as a matter of fact in the magnitude from the configuration by the side of a body to an image sensor. However, the aberration amendment level of image pick-up

equipment is also improving by leaps and bounds with a raise in a pixel to an image sensor in recent years. For this reason, the thing to which the number of sheets of the lens element of the zoom lens system contained in image pick-up equipment is also increasing steadily and for which a thin shape is attained also in the time (the so-called collapsed state) of un-using it for the thickness of a lens element is difficult.

[0033]

On the other hand, since it becomes possible to make [by adopting the configuration which bends the optical axis of body light 90 degrees of abbreviation according to a reflector like the zoom lens system of each operation gestalt] small most magnitude of the thickness direction of image pick-up equipment to the magnitude from the lens by the side of a body to a reflector at the time of un-using it, it becomes possible to attain thin shape-ization on the appearance of image pick-up equipment. Moreover, since the optical path of body light can be piled up near the reflector by adopting the configuration which bends the optical axis of body light 90 degrees of abbreviation according to a reflector, space can be used effectively and the further miniaturization of image pick-up equipment can be attained.

[0034]

As for the location of a reflector, it is desirable that it is the 1st lens group Gr1 interior. By arranging to the 1st lens group Gr1 interior arranged most at the body side, it becomes possible to make magnitude of the thickness direction of image pick-up equipment into min.

[0035]

As for the 1st lens group Gr1 in which a reflector is included, it is desirable to have negative power. When the 1st lens group Gr1 has negative power, it becomes possible to make magnitude of the reflector in a reflector location small. Moreover, a zoom lens system becomes the so-called negative lead type by adopting the configuration whose 1st lens group Gr1 has negative power. As for a negative lead type zoom lens system, in a large focal distance field, it becomes easy and is desirable to attain image side tele cent rucksack nature required for the optical system for being easy to take a retro focus type configuration, and forming an optical image in an image sensor.

[0036]

Although (a) internal reflection prism (operation gestalt), (b) surface reflecting prism, (C) internal reflection monotonous mirror, a (d) surface reflective mirror,

and ******** may be used for a reflector, its (a) internal reflection prism is the optimal. In order that body light may pass through the inside of the medium of prism by adopting internal reflection prism, the spacing at the time of penetrating prism turns into a short conversion spacing from spacing more nearly physical than the usual air spacing according to the refractive index of a medium. For this reason, when internal reflection prism is adopted as a configuration of a reflector, an equivalent configuration can be attained in a compacter tooth space, and it is optically desirable.

[0037]

When it constitutes a reflector from internal reflection prism, as for the quality of the material of prism, it is desirable to satisfy the following conditions.

[0038]

Np>=1.55 .... (1)

It corrects,

Np is the refractive index of the quality of the material of prism,

It comes out.

[0039]

If the refractive index of prism turns around the above-mentioned range the

bottom, the contribution to miniaturization becomes small and is not desirable.

[0040]

Furthermore, it is desirable that it is in the following range in addition to the above-mentioned range.

[0041]

Np>=1.7 .... (1)'

Moreover, a reflector may not be a perfect total reflection side. Some reflection factors are suitably adjusted among reflectors, it is made to branch and incidence of a part of body light may be carried out to the sensor for a photometry or ranging. Furthermore, the reflection factor of the whole reflector surface may be adjusted suitably, and finder light may be branched. Furthermore, with each operation gestalt, although each of plane of incidence of prism and outgoing radiation sides is flat surfaces, you may be a field with power.

[0042]

As for a body side, it is more desirable than a reflector to consist of lens elements of two or less sheets. Since the substantial thickness of optical system will be determined by the structure of having Rhythm PR, at spacing from the body side face of the lens arranged most at the body side to a reflector so that it

may have the reflector which bends the optical axis of body light 90 degrees of abbreviation in the interior of the 1st group, it becomes possible from a reflector to acquire thin optical system by constituting the configuration by the side of a body from a lens element of two or less sheets. When the 1st lens group Gr1 is especially constituted only from a lens element of one sheet, and a reflector, the degree of freedom of a camera cone configuration can be made to increase, and low cost-ization of image pick-up equipment can be attained. Moreover, when the 1st lens group Gr1 is constituted only from a lens element of two sheets, and a reflector, amendment of relative eccentric aberration is attained and it is advantageous on optical-character ability.

[0043]

Furthermore, as for the 1st lens group Gr1, it is desirable at the time of variable power that it is immobilization to the image surface. While needing a big tooth space when it is made to move since the reflector is included in the 1st lens group Gr1, when the reflector is especially constituted from prism, prism with big weight must be moved, a drive will be forced a big burden, and it is not desirable. Moreover, by making the 1st lens group Gr1 immobilization to the image surface at the time of variable power, the optical system which does not carry out

overall-length change can be acquired, and it is desirable. Moreover, a camera cone configuration can also be simplified and it becomes possible to attain low cost-ization of the whole image pick-up equipment. Furthermore, since initialization of the control system for control of a migration group becomes easy especially in a digital camera at the time of a zoom by adopting the configuration which fixes the 1st lens group Gr1 at the time of zooming, it becomes [to shorten time amount required by the condition which can be photoed] possible from the time of a main power supply ON and is desirable.

[0044]

The configuration which also makes negative power the 2nd lens group Gr2 following the 1st lens group Gr1 which has negative power is used for the zoom lens system of each operation gestalt. It is easy to adopt the configuration which makes the above-mentioned 1st lens group immobilization by this configuration and is desirable.

[0045]

As for the zoom lens system of each operation gestalt, it is desirable to satisfy the following conditions.

[0046]

$2 < |f1 / fw| < 4$ (2)

It corrects,

f1: The focal distance of the 1st lens group,

fw: The focal distance in the wide angle edge of the whole system,

It comes out.

[0047]

Conditional expression (2) has specified the desirable focal distance of the 1st lens group Gr1. If the upper limit of conditional expression (2) is exceeded, since the focal distance of the 1st lens group Gr1 will become large too much, an overall length or distance from a reflector to an image sensor cannot be made small as a result, and it is not desirable. Since the negative power of the 1st lens group Gr1 becomes weak too much, the lens outer diameter which constitutes the 1st lens group Gr1 becomes large, and it becomes impossible moreover, to attain a compact zoom lens system. Conversely, if the minimum of conditional expression (2) is exceeded, since the focal distance of the 1st lens group Gr1 will become short too much, the negative distortion generated by the 1st lens group Gr1 in a wide angle edge becomes large too much, and it becomes difficult to perform the amendment.

[0048]

Although each lens group which constitutes each operation gestalt consists of only refraction mold lenses (that is, lens of the type with which a deviation is performed by the interface of the media which have a different refractive index) which deflect an incident ray by refraction, it is not restricted to this. For example, each lens group may consist of a diffraction mold lens which deflects an incident ray by diffraction, a refraction / diffraction hybrid mold lens which deflects an incident ray with the combination of a diffraction operation and a refraction operation, a refractive-index distribution lens which deflects an incident ray according to the refractive-index distribution in a medium.

[0049]

[Example]

Construction data, an aberration Fig., etc. are mentioned and the configuration of the zoom lens system hereafter contained in the image pick-up equipment which carried out this invention etc. is explained still more concretely. The lens block diagram (drawing 1 thru/or 4) which the example 1 explained as an example here thru/or 4 support the 1st thru/or 4th operation gestalt mentioned above, respectively, and expresses the 1st thru/or 4th operation gestalt shows a

corresponding example 1 thru/or the corresponding lens configuration of 4, respectively.

[0050]

In the construction data of each example, ri (i = 1, 2, 3 ....) is counted from a body side. The radius of curvature of the i-th field (mm), Count di (i = 1, 2, 3 ....) from a body side, and the i-th axial top-face spacing (mm) is shown. nickel (i = 1, 2, 3 ....) and nui (i = 1, 2, 3 ....) are counted from a body side, and show the refractive index (Nd) and the Abbe number (nud) to d line of the i-th optical element. Moreover, axial top-face spacing which changes in zooming shows the value of the variable spacing in the shortest focal distance condition (wide angle edge, W) - middle focal distance condition (middle, M) - longest focal distance condition (a tele edge, T) among construction data. The focal distance (f, mm) and the f number (FNO) of the whole system corresponding to each focal distance condition (W), (M), and (T) are combined with other data, and are shown.

[0051]

It shall be shown that the field where * was given to radius of curvature ri is a field which consisted of the aspheric surfaces, and it shall define as the formula

(AS) of the following showing the field configuration of the aspheric surface. The aspheric surface data of each example are combined with other data, and are shown.

[0052]

r13 = 8.858

d13 = 0.100

r14 = 6.329

d14 = 2.301 N7 = 1.48749 ν7 = 70.44

r15* = 16.784

d15 = 0.996

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν2 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = 0.31440E-03

A6 = 0.40741E-05

A8 = -0.13254E-06

A10= 0.88372E-09

r2*

ε = 0.10000E+01

A4 = -0.14549E-03

A6 = 0.90366E-05

A8 = 0.23593E-06

A10= -0.68590E-08

r8*

ε = 0.10000E+01

A4 = 0.60518E-03

A6 = 0.22274E-04

Drawing 5 thru/or drawing 8 are the aberration Figs. of an example 1 - an example 4, and expresses the aberration in the infinite distance focus condition of the zoom lens system of each example. among drawing 5 thru/or drawing 8 , the shortest focal distance condition and (M) can be set in the middle focal

distance condition, and (W) can set (T) in the longest focal distance condition -- many -- astigmatism and distortion aberration, such as spherical aberration, and Y' (mm) show maximum image quantity (considerable from optical axis to distance)} on an image sensor sequentially from the aberration {left. In the spherical-aberration Fig., spherical aberration [as opposed to d line in a continuous line (d)], spherical aberration [as opposed to g line in an alternate long and short dash line (g)], spherical aberration [as opposed to c line in a two-dot chain line (c)], and a broken line (SC) express sine condition. In the astigmatism Fig., a broken line (DM) expresses the astigmatism in a meridional side, and the continuous line (DS) expresses the astigmatism in a sagittal side. Moreover, in the distortion aberration Fig., the continuous line expresses distortion % to d line.

[0053]

[Effect of the Invention]

Compact image pick-up equipment can be offered it being highly efficient and having a high scale-factor zoom lens system according to the zoom lens system of each operation gestalt, as explained above.

[Brief Description of the Drawings]

[Drawing 1] The lens block diagram of the 1st operation gestalt (example 1).

[Drawing 2] The lens block diagram of the 2nd operation gestalt (example 2).

[Drawing 3] The lens block diagram of the 3rd operation gestalt (example 3).

[Drawing 4] The lens block diagram of the 4th operation gestalt (example 4).

[Drawing 5] The aberration Fig. in the infinite distance focus condition of an example 1.

[Drawing 6] The aberration Fig. in the infinite distance focus condition of an example 2.

[Drawing 7] The aberration Fig. in the infinite distance focus condition of an example 3.

[Drawing 8] The aberration Fig. in the infinite distance focus condition of an example 4.

[Drawing 9] The block diagram showing the outline of this invention.

[Description of Notations]

LPF: The plane-parallel plate equivalent to an optical low pass filter

SR: Image sensor

TL: Zoom lens system

Gr1: The 1st lens group Gr1

Gr2: The 2nd lens group Gr2

PR: Internal reflection prism

ST: Diaphragm

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The lens block diagram of the 1st operation gestalt (example 1).

[Drawing 2] The lens block diagram of the 2nd operation gestalt (example 2).

[Drawing 3] The lens block diagram of the 3rd operation gestalt (example 3).

[Drawing 4] The lens block diagram of the 4th operation gestalt (example 4).

[Drawing 5] The aberration Fig. in the infinite distance focus condition of an example 1.

[Drawing 6] The aberration Fig. in the infinite distance focus condition of an example 2.

[Drawing 7] The aberration Fig. in the infinite distance focus condition of an example 3.

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[Description of Notations]

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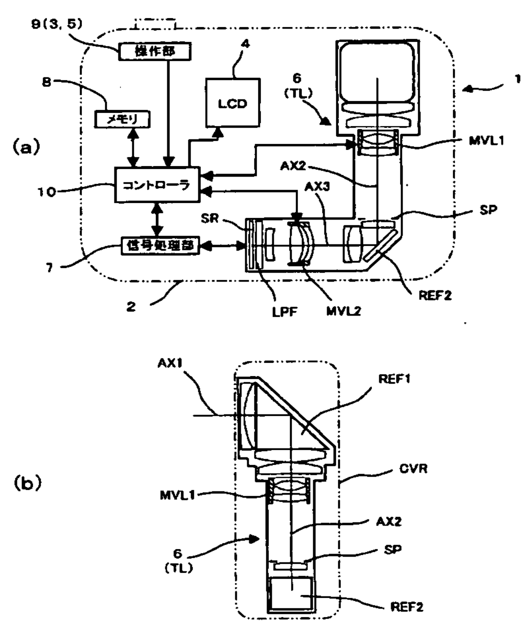
最終頁に続く

(54)【発明の名称】撮像レンズ装置およびそれを備えたデジタルカメラ

(57)【要約】
【課題】小型で高倍率かつ高画質を満足する全く新規な、ズームレンズ系を備えた撮像レンズ装置を提供する。
【解決手段】撮像レンズ系（ＴＬ）はズームレンズである。第１の光軸（ＡＸ１）は第１の反射部材（ＲＥＦ１）により９０°折り曲げられる。第１の反射部材（ＲＥＦ１）により折れ曲がった第２の光軸（ＡＸ２）上には、第１の移動レンズ群（ＭＶＬ１）と絞り（ＳＰ）が配置されている。第２の光軸（ＡＸ２）は第２の反射部材（ＲＥＦ２）により、第１の光軸と垂直な平面内に９０°折り曲げられる。第２の反射部材（ＲＥＦ２）により折れ曲がった第３の光軸（ＡＸ３）上には第２の移動レンズ群（ＭＶＬ２）が配置されている。ズーミングにおいて、第１の反射部材（ＲＥＦ１）と絞り（ＳＰ）と第２の反射部材（ＲＥＦ２）とは位置固定で、第２の光軸上を第１の移動レンズ群が、第３の光軸上を第２の移動レンズ群が移動する。
【選択図】 図１



【特許請求の範囲】
【請求項１】
複数の群からなり群間隔を変えることにより変倍を行うズームレンズ系と、
ズームレンズ系により形成された光学像を電気信号に変換する撮像素子と、
を備えた撮像レンズ装置であって、
ズームレンズ系は、物体側から順に
第１の反射面と、第１の移動レンズ群と、第２の反射面と、第２の移動レンズ群とを含み、
入射光軸は、第１の反射面によって略９０°折り曲げられ、さらに第２の反射面によって光軸が折り曲げられ、
ズーミングにおいて、
第１の反射面と第２の反射面は位置固定で、第１の移動レンズ群と、第２の移動レンズ群とが光軸上を移動することを特徴とする撮像レンズ装置。
【請求項２】
前記第１の移動レンズ群は負の光学的パワーを有し、前記第２の移動レンズ群は正の光学的パワーを有することを特徴とする請求項１に記載の撮像レンズ装置。
【請求項３】
複数の群からなり群間隔を変えることにより変倍を行うズームレンズ系と、
ズームレンズ系により形成された光学像を電気信号に変換する撮像素子と、
を備えた撮像レンズ装置であって、
ズームレンズ系は、物体側から順に、
第１の反射面と、絞りと、第２の反射面とを含み、
入射光軸は、第１の反射面によって略９０°折り曲げられ、さらに第２の反射面によって光軸が折り曲げられ、
ズーミングにおいて、第１の反射面と、絞りと、第２の反射面とは位置固定で、絞りと第２の反射面との距離をＤ２、広角端でのズームレンズ系の焦点距離をｆｗとする時、
$$0.3 < D2 / fw < 3$$
を満足することを特徴とする撮像レンズ装置。
【請求項４】
前記第１の反射面と前記第２の反射面との間に配置された負の光学的パワーを有する第１の移動レンズ群と、前記第２の反射面より像側に配置された正の光学的パワーを有する第２の移動レンズ群とを有し、
前記第１の反射面は正の光学的パワーを有する群に含まれることを特徴とする請求項３に記載の撮像レンズ装置。
【請求項５】
請求項１または３に記載の撮像レンズ装置であって、
以下の条件式を満足することを特徴とする撮像レンズ装置。
$$2 < |fa1 / fw| < 8$$
ただし、
ｆａ１：第１反射面より物体側の群の焦点距離、
ｆｗ：広角端でのズームレンズ系の焦点距離、
である。
【請求項６】
前記第２の移動群の移動によりフォーカシングが行われることを特徴とする請求項１または４に記載の撮像レンズ装置。
【請求項７】
請求項１乃至６のいずれかに記載の撮像レンズ装置を備えたデジタルカメラ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】

本発明は、撮像レンズ装置に関するものであり、さらに詳しくは、デジタルカメラやデジタルビデオカメラ等のデジタル入出力機器に好適なコンパクトで高変倍率を有するズームレンズ系を備えた撮像レンズ装置に関する。また、そのような撮像レンズ装置を備えたデジタルカメラに関する。

【０００２】

【従来の技術】

近年、パーソナルコンピュータ等の普及に伴い、手軽に画像情報をデジタル機器に取り込むことができるデジタルスチルカメラやデジタルビデオカメラ等（以下デジタルカメラと呼称する）が個人ユーザレベルで普及しつつある。このようなデジタルカメラは、今後も画像情報の入力機器として益々普及することが予想される。

【０００３】

ところでデジタルカメラの画質は、一般にＣＣＤ（Ｃｈａｒｇｅ Ｃｏｕｐｌｅｄ Ｄｅｖｉｃｅ）等の固体撮像素子の画素数で決定される。現在、一般向けのデジタルカメラは１００万画素を超える高画素化がなされており、画質の面で銀塩カメラに近づこうとしている。これらの一般向けデジタルカメラにおいても画像の変倍、特に画像劣化が少ない光学変倍を行うことも望まれるため、近年では、小型で高変倍率かつ高画質を満足するデジタルカメラ用ズームレンズが要求されるようになってきている。

【０００４】

小型化に関しては、レンズ間にプリズムあるいは反射ミラーを挿入することで光学系を折り曲げ、光軸方向の小型化を更に推し進めている。特許文献１には、光軸を１回折り曲げた単焦点レンズが記載されている。また、特許文献２には、光軸を２回折り曲げた単焦点レンズが記載されている。

【０００５】

【特許文献１】特開平６－１０７０７０号公報

【特許文献２】欧州特許第０９０６５８７Ｂ１号明細書

【発明が解決しようとする課題】

しかしながら、特許文献１および特許文献２に記載されている光学系は、光路を折り曲げることにより小型化を図っているが、単焦点レンズであり、高変倍率で高画質を満足するズームレンズではない。５倍程度の高変倍率のズームレンズにおいては、レンズ枚数も多く、また、可動群の移動量も大きいために全長が大きくなってしまい、カメラ本体が大型化してしまうことが避けられない。また、無理に光学系の全長を小さくしようとすると、誤差感度の増大を招き、製造誤差が光学性能に大きく影響してしまう。また、ズーム中の可動群を多くして、光学全長を小型化した場合、鏡胴構成が複雑になってしまい、カメラ本体が大型化してしまう。さらに、高画質で高変倍率なズームレンズを小型化するために光路を折り曲げるには、移動群の配置や鏡胴構成を考慮する必要がある。

【０００６】

以上の問題に鑑み、本発明は、小型で高変倍率かつ高画質を満足する全く新規な、ズームレンズ系を備えた撮像レンズ装置を提供することを目的とする。また、そのような撮像レンズ装置を備えたデジタルカメラを提供する。

【０００７】

【課題を解決するための手段】

上記目的を達成するため、第１の発明の撮像レンズ装置は、複数の群からなり群間隔を変えることにより変倍を行うズームレンズ系と、ズームレンズ系により形成された光学像を電気信号に変換する撮像素子と、を備えた撮像レンズ装置であって、ズームレンズ系は、物体側から順に第１の反射面と、第１の移動レンズ群と、第２の反射面と、第２の移動レンズ群とを含み、入射光軸は、第１の反射面によって略９０°折り曲げられ、さらに第２の反射面によって光軸が折り曲げられ、ズーミングにおいて、第１の反射面と第２の反射面は位置固定で、第１の移動レンズ群と、第２の移動レンズ群とが光軸上を移動する。

【０００８】

第２の発明の撮像レンズ装置は、上記第１の発明の構成において、前記第１の移動群は負

の光学的パワーを有し、前記第２の移動群は正の光学的パワーを有する。

【０００９】

第３の発明の撮像レンズ装置は、複数の群からなり群間隔を変えることにより変倍を行うズームレンズ系と、ズームレンズ系により形成された光学像を電気信号に変換する撮像素子と、を備えた撮像レンズ装置であって、ズームレンズ系は、物体側から順に、第１の反射面と、絞りと、第２の反射面とを含み、入射光軸は、第１の反射面によって略９０°折り曲げられ、さらに第２の反射面によって光軸が折り曲げられ、ズーミングにおいて、第１の反射面と、絞りと、第２の反射面とは位置固定で、絞りと第２の反射面との距離をＤ２、広角端でのズームレンズ系の焦点距離をｆｗとする時、

０．３＜ Ｄ２ ／ ｆｗ ＜３

を満足する。

【００１０】

第４の発明の撮像レンズ装置は、上記第３の発明の構成において、前記第１の反射面と前記第２の反射面との間に配置された負の光学的パワーを有する第１の移動レンズ群と、前記第２の反射面より像側に配置された正の光学的パワーを有する第２の移動レンズ群とを有し、前記第１の反射面は正の光学的パワーを有する群に含まれる。

【００１１】

第５の発明の撮像レンズ装置は、上記第１または第３の発明の構成において、以下の条件式を満足することを特徴とする撮像レンズ装置である。

２＜｜ｆａ１ ／ ｆｗ｜＜８

ただし、

ｆａ１：第１反射面より物体側の群の焦点距離、

ｆｗ：広角端でのズームレンズ系の焦点距離、

である。

【００１２】

第６の発明の撮像レンズ装置は、上記第１または第４の発明の構成において、前記第２の移動群の移動によりフォーカシングが行われる。

【００１３】

また、第７の発明は、上記第１乃至第６のいずれかの発明の構成を有する撮像レンズ装置を備えたデジタルカメラである。

【００１４】

【発明の実施の形態】

以下、本発明を実施した撮像レンズ装置を、図面を参照しつつ説明する。被写体の映像を光学的に取り込んで電気的な信号として出力する撮像レンズ装置は、被写体の静止画撮影や動画撮影に用いられるカメラ｛例えば、デジタルカメラ；ビデオカメラ；デジタルビデオユニット、パーソナルコンピュータ、モバイルコンピュータ、携帯電話、情報携帯端末（ＰＤＡ）等に内蔵又は外付けされるカメラ｝の主たる構成要素である。

【００１５】

図１４は、本発明に係るデジタルカメラの概略外観図であり、図１４（ａ）は、デジタルカメラの正面図、図１４（ｂ）は、デジタルカメラの背面図である。デジタルカメラ１は、前面に撮像レンズ装置６が、上面にレリーズボタン３が、背面には、液晶モニター（ＬＣＤ）４および操作ボタン５が配置されている。

【００１６】

図１は、デジタルカメラの内部構成の概略を示す図であり、図１（ａ）はデジタルカメラの正面図、図１（ｂ）は撮像レンズ装置の側面図に対応する。被写体は図１（ａ）においては紙面手前側、図１（ｂ）においては紙面左側に位置する。図１において、二点鎖線で示される線は、撮像レンズ装置６を有するデジタルカメラの筐体２を表している。その撮像レンズ装置６は、物体（被写体）側から順に、物体の光学像を形成する撮影レンズ系（ＴＬ）と、光学的ローパスフィルタ等に相当する平行平面板（ＬＰＦ）と、撮影レンズ系（ＴＬ）により形成された光学像を電気的な信号に変換する撮像素子（ＳＲ）と、で構成

される。

【００１７】

撮像素子（ＳＲ）としては、例えば複数の画素から成るＣＣＤやＣＭＯＳ（Ｃｏｍｐｌｅｍｅｎｔａｒｙ Ｍｅｔａｌ Ｏｘｉｄｅ Ｓｅｍｉｃｏｎｄｕｃｔｏｒ）センサー等の固体撮像素子が用いられ、撮像レンズ系（ＴＬ）により形成された光学像が電気的な信号に変換される。また撮像レンズ系（ＴＬ）で形成されるべき光学像は、撮像素子（ＳＲ）の画素ピッチにより決定される所定の遮断周波数特性を有する光学的ローパスフィルタ（ＬＰＦ）を通過することにより、電気的な信号に変換される際に発生するいわゆる折り返しノイズが最小化されるように、空間周波数特性が調整される。

【００１８】

撮像素子（ＳＲ）で生成された信号は、信号処理部７によって所定のアナログ画像処理、デジタル画像処理や画像圧縮処理等が施されてデジタル映像信号としてメモリ８（半導体メモリ，光ディスク等）に記録されたり、場合によってはケーブルを介したり赤外線信号に変換されたりして他の機器に伝送される。コントローラ１０は、マイクロコンピュータからなり、撮影機能、画像再生機能あるいはズーミングおよびフォーカシングのためのレンズ移動機構等を集中的に制御するものである。液晶モニター４は、撮像素子（ＳＲ）によって変換された画像信号を画像として表示する、あるいはメモリー８に記録された画像信号を画像として表示するものである。操作部９は、レリーズボタン３、操作ボタン５等の各種ダイヤル、ボタンを包括するものであり、ユーザーによって操作入力される情報は操作部９を介して、コントローラ１０に伝達される。

【００１９】

次に撮像レンズ系（ＴＬ）について図１を使用して説明する。撮像レンズ系（ＴＬ）はズームレンズ系である。入射光軸である第１の光軸（ＡＸ１）は第１の反射部材（ＲＥＦ１）によって９０°折り曲げられる。第１の反射部材（ＲＥＦ１）によって折れ曲がった第２の光軸（ＡＸ２）上には、第１の移動レンズ群（ＭＶＬ１）と絞り（ＳＰ）が配置されている。第２の光軸（ＡＸ２）は第２の反射部材（ＲＥＦ２）によってさらに第１の光軸と垂直な方向に９０°折り曲げられる。第２の反射部材（ＲＥＦ２）によって折れ曲がった第３の光軸（ＡＸ３）上には第２の移動レンズ群（ＭＶＬ２）が配置されている。第１の光軸（ＡＸ１）、第２の光軸（ＡＸ２）および第３の光軸（ＡＸ３）は互いに垂直である。撮像レンズ系（ＴＬ）のズーミングにおいて、第１の反射部材（ＲＥＦ１）と絞り（ＳＰ）と第２の反射部材（ＲＥＦ２）とは位置固定で、第２の光軸上を第１の移動レンズ群（ＭＶＬ１）が、第３の光軸上を第２の移動レンズ群（ＭＶＬ２）が移動する。これらの移動レンズ群の移動は、コントローラ１０によって制御される。

【００２０】

デジタルカメラ１は、上記説明の撮像レンズ装置６によって、薄型化とコンパクト化が可能となる。第１の光軸（ＡＸ１）が９０°折り曲げられ、第２の光軸が第１の光軸に対し垂直な方向に折り曲げられることにより入射光軸方向に薄型化できる。また、第２の光軸（ＡＸ２）が折り曲げられることにより、全長の長い高倍率ズームレンズであってもコンパクト化が可能となる。なお、撮像レンズ系（ＴＬ）における、第３の光軸（ＡＸ３）は第２の光軸（ＡＸ２）と垂直でなくともよいが、第２、第３の光軸が第１の光軸と垂直な平面内にあることが望ましい。そのように構成することで、入射光軸方向に薄型化できる。また、第１の光軸（ＡＸ１）と第３の光軸（ＡＸ３）が平行であり、第１および第３の光軸と第２の光軸が垂直であってもよい。この場合には、デジタルカメラの横幅を小さく薄くできる。

【００２１】

図２～図５は、上記撮像レンズ装置の、第１～第４の実施の形態を構成するズームレンズ系にそれぞれ対応するレンズ構成図であり、広角端（Ｗ）でのレンズ配置を光学断面で示している。各レンズ構成図中の矢印ｍｊ（ｊ＝１，２，．．．）は、広角端（Ｗ）から望遠端（Ｔ）へのズーミングにおける第ｊ群（Ｇｒｊ）等の移動をそれぞれ模式的に示しており、矢印ｍＦは無限遠から近接へのフォーカシングにおけるフォーカス群の移動方向を

示している。また、各レンズ構成図中、ｒｉ（ｉ＝１，２，３，．．．）が付された面は物体側から数えてｉ番目の面であり、ｒｉに＊印が付された面は非球面である。ｄｉ（ｉ＝１，２，３，．．．）が付された軸上面間隔は、物体側から数えてｉ番目の軸上面間隔のうち、ズーミングにおいて変化する可変間隔である。なお、図２～図５のそれぞれのレンズ構成図は、便宜上、光軸が折り曲げられておらず、一直線上にレンズが配置されている。したがって、折り曲げのための直角プリズムＲＥＦ１の形状および反射ミラーＲＥＦ２は図示されていない。

【００２２】

各実施形態のズームレンズ系はいずれも、物体側から順に、正のパワーを有する第１レンズ群（Ｇｒ１）と、負のパワーを有する第２レンズ群と（Ｇｒ２）、正のパワーを有する第３レンズ群（Ｇｒ３）と、正のパワーを有する第４レンズ群（Ｇｒ４）と、を有する。広角端［Ｗ］から望遠端［Ｔ］への変倍時に、第２レンズ群（Ｇｒ２）は広角端［Ｗ］での位置よりも常に像面側に位置するように移動し（バリエータ）、第４レンズ群は第２レンズ群の移動に伴う像点移動を補正するように移動し（コンペンセータ）、各レンズ群の間隔を変えることにより変倍を行う構成となっている。

【００２３】

そして、固体撮像素子（例えばＣＣＤ）を備えたカメラ（例えばデジタルスチルカメラ）に用いられるズームレンズ系として、その像面側には光学的ローパスフィルタ等に相当するガラス製の平行平面板（ＬＰＦ）が配置されている。いずれの実施の形態においても、第１レンズ群（Ｇｒ１）は、物体側から順に少なくとも１枚の負レンズと光軸を折り曲げるための直角プリズム（ＲＥＦ１）と、２枚の正レンズとを含むレンズで構成されている。また、第２レンズ群（Ｇｒ２）と第３レンズ群（Ｇｒ３）には接合レンズが用いられている。各実施の形態のレンズ構成をさらに詳しく以下に説明する。なお、図２～図５の最も像面側に配置されている平行平面板は撮像素子（ＳＲ）のカバーガラスである。

【００２４】

《第１の実施の形態（図２、正負正正負）》第１の実施の形態のズームレンズ系は正・負・正・正・負の５群ズームレンズであり、各レンズ群は物体側から順に以下のように構成されている。第１レンズ群（Ｇｒ１）は、像面側に凹の負メニスカスレンズと、光軸を９０°折り曲げるための第１の反射部材である直角プリズムＲＥＦ１（図２では平行平板で表示）と、両凸の正レンズと、物体側に凸の正メニスカスレンズ（略平凸レンズ）と、で構成されている。第２レンズ群（Ｇｒ２）は、両面非球面を有する負レンズと物体側に両凹の負レンズ及び両凸の正レンズから成る接合レンズと、で構成されており、第２の光軸（ＡＸ２）上に配置される。第３レンズ群（Ｇｒ３）は、絞り（ＳＰ）と、両凸の正レンズと、両凸の正レンズ及び物体側に凹の負メニスカスレンズから成る接合レンズと、で構成されている。両凸の正レンズと接合レンズとの間（ｄ１６）に反射ミラーＲＥＦ２（図示しない）が配置される。第４レンズ群（Ｇｒ４）は、物体側に非球面を有し物体側に凸の負メニスカスレンズと、両凸の正レンズと、で構成されており、第３の光軸（ＡＸ３）上に配置される。第５レンズ群（Ｇｒ５）は、両面非球面を有し物体側に凹の負メニスカスレンズで構成されている。

【００２５】

《第２の実施の形態（図３、正負正正正）》第２の実施の形態のズームレンズ系は正・負・正・正・正の５群ズームレンズであり、各レンズ群は物体側から順に以下のように構成されている。第１レンズ群（Ｇｒ１）は、像面側に凹の負メニスカスレンズと、光軸を９０°折り曲げるための第１の反射部材である直角プリズムＲＥＦ１（図３では平行平板で表示）と、両凸の正レンズと、物体側に凸の正メニスカスレンズと、で構成されている。第２レンズ群（Ｇｒ２）は、両面非球面を有する負レンズと両凹の負レンズ及び両凸の正レンズから成る接合レンズと、で構成されており、第２の光軸（ＡＸ２）上に配置される。第３レンズ群（Ｇｒ３）は、絞り（ＳＰ）と、両凸の正レンズと、両凸の正レンズ及び物体側に凹の負メニスカスレンズから成る接合レンズと、で構成されている。両凸の正レンズと接合レンズとの間（ｄ１６）に反射ミラーＲＥＦ２（図示しない）が配置される。

第４レンズ群（Ｇｒ４）は、物体側に非球面を有し物体側に凸の負メニスカスレンズと、物体側に凸の正メニスカスレンズと、で構成されており、第３の光軸（ＡＸ３）上に配置される。第５レンズ群（Ｇｒ５）は、両面非球面を有し物体側に凹の正メニスカスレンズで構成されている。

【００２６】

《第３の実施の形態（図４、正負正正）》第３の実施の形態のズームレンズ系は正・負・正・正の４群ズームレンズであり、各レンズ群は物体側から順に以下のように構成されている。第１レンズ群（Ｇｒ１）は、像面側に凹の負メニスカスレンズと、光軸を９０°折り曲げるための第１の反射部材である直角プリズムＲＥＦ１（図４では平行平板で表示）と、両凸の正レンズと、物体側に凸の正メニスカスレンズと、で構成されている。第２レンズ群（Ｇｒ２）は、両面非球面を有する負レンズと物体側に凹の負メニスカスレンズ及び像面側に凸の正メニスカスレンズから成る接合レンズと、で構成されており、第２の光軸（ＡＸ２）上に配置される。第３レンズ群（Ｇｒ３）は、絞り（ＳＰ）と、物体側に凸面をもつ正のメニスカスレンズ（略平凸レンズ）と、両凸の正レンズ及び物体側に両凹の負レンズから成る接合レンズと、で構成されている。正レンズと接合レンズとの間（ｄ１６）に反射ミラーＲＥＦ２（図示しない）が配置される。第４レンズ群（Ｇｒ４）は、物体側に非球面を有し物体側に凸の負メニスカスレンズと、両凸の正レンズと、で構成されており、第３の光軸（ＡＸ３）上に配置される。

【００２７】

《第４の実施の形態（図５、正負正正正）》第４の実施の形態のズームレンズ系は正・負・正・正・正の５群ズームレンズであり、各レンズ群は物体側から順に以下のように構成されている。第１レンズ群（Ｇｒ１）は、像面側に凹の負メニスカスレンズと、光軸を９０°折り曲げるための第１の反射部材である直角プリズムＲＥＦ１（図５では平行平板で表示）と、両凸の正レンズと、両凸の正レンズと、で構成されている。第２レンズ群（Ｇｒ２）は、両面非球面を有する負レンズと両凹の負レンズ及び両凸の正レンズから成る接合レンズと、で構成されており、第２の光軸（ＡＸ２）上に配置される。第３レンズ群（Ｇｒ３）は、絞り（ＳＰ）と、両凸の正レンズと、両凸の正レンズ及び両凹の負レンズから成る接合レンズと、で構成されている。接合レンズの像側（ｄ１９）に反射ミラーＲＥＦ２（図示しない）が配置される。第４レンズ群（Ｇｒ４）は、物体側に非球面を有し物体側に凸の負メニスカスレンズと、両凸の正レンズと、で構成されており、第３の光軸（ＡＸ３）上に配置される。第５レンズ群（Ｇｒ５）は、両面非球面を有し物体側に凸の正メニスカスレンズで構成されている。

【００２８】

上記第１、第２および第４の実施の形態では、広角端［Ｗ］から望遠端［Ｔ］への変倍時に、第１レンズ群（Ｇｒ１）、第３レンズ群（Ｇｒ３）および第５レンズ群（Ｇｒ５）の位置は固定で、第２レンズ群（Ｇｒ２）が広角端［Ｗ］での位置よりも常に像面側に位置するように第２の光軸上を移動し、第４のレンズ群（Ｇｒ４）は、第３の光軸上を物体側に移動した後、像面側にＵターンする。

【００２９】

上記第３の実施の形態では、広角端［Ｗ］から望遠端［Ｔ］への変倍時に、第１レンズ群（Ｇｒ１）および第３レンズ群（Ｇｒ３）の位置は固定で、第２レンズ群（Ｇｒ２）が広角端［Ｗ］での位置よりも常に像面側に位置するように第２の光軸上を移動し、第４のレンズ群（Ｇｒ４）は、第３の光軸上を物体側に移動した後、像面側にＵターンする。

【００３０】

上記の説明のように、いずれの実施の形態においても、第２の光軸（ＡＸ２）上を第２レンズ群（Ｇｒ２）が移動し、第３の光軸（ＡＸ３）上を第４レンズ群（Ｇｒ４）が移動することで、変倍が行われる。各移動群が異なる光軸上に配置されており、各移動機構が独立して構成できるため、簡略で小型な鏡胴構成が可能となる。

【００３１】

また、第１の反射部材を含み物体光が入射する第１レンズ群（Ｇｒ１）は位置固定で、第

２レンズ群が（Ｇｒ２）が第２の光軸上を移動し、第４レンズ群（Ｇｒ４）が第３の光軸上を移動するインナーズーム方式のため、ズーミングにおいてレンズの飛び出しがなく、いつもカメラがフラットな状態で撮影ができる。

【００３２】

ズームレンズ系は以下に示す条件式を満たすことが望ましい。これにより、コンパクト性に優れた高倍率のズームレンズ系を実現することができる。なお、以下に説明する個々の条件をそれぞれ単独に満たせば、それに対応する作用効果を達成することは可能であるが、複数の条件を満たす方が、光学性能，小型化等の観点からより望ましいことはいうまでもない。

【００３３】

以下の条件式（１）を満足することが望ましい。

$0.3 < D2 / fw < 3$ （１）

ただし、

Ｄ２：絞りと第２反射部材の反射面との距離、

ｆｗ：広角端でのズームレンズ系の焦点距離、

である。

条件式（１）は、絞りと第２反射面との距離を規定する条件である。条件式（１）の上限値を超えると絞りと第２反射面との距離が大きくなりすぎるため、反射部材が大きくなり、小型化という面で好ましくない。条件式（１）の下限値を下回ると絞りと第２反射面との距離が近づきすぎるため折り返しが困難になる。

【００３４】

条件式（１）は、さらに

$0.8 < D2 / fw < 2.5$ （１）´

であることがより好ましい。条件式（１）´により、第２の反射部材をより小型化できるとともに、絞りと第２反射面との干渉条件が緩和され、より自由なレンズ構成が可能となり収差補正が容易になる。

【００３５】

また、以下の、条件式（２）を満足することが望ましい。

$2 < |fa1 / fw| < 8$ （２）

ただし、

ｆａ１：第１反射面より物体側の群の焦点距離、

ｆｗ：広角端での焦点距離、

である。

条件式（２）は第１反射面より物体側の群の焦点距離を規定する条件である。条件式（２）の下限値を下回ると第１反射面より物体側の群の焦点距離（絶対値）が小さくなり過ぎるため、歪曲収差特に広角側での負の歪曲収差が著しくなり、良好な光学性能を確保することが困難になる。逆に条件式（２）の上限を超えると、第１反射面より物体側の群の焦点距離（絶対値）が大きくなりすぎる。その結果、第１群のレンズ系および反射部材の大型化を招き、コンパクト化という点では好ましくない。

【００３６】

条件式（２）は、さらに、

$4 < |fa1 / fw| < 6.5$ （２）´

であることがより好ましく、そうすることで、より良好な光学性能とコンパクト化の両立が可能となる。

【００３７】

また、レンズ重量のできるだけ小さい群でフォーカシングを行うことが望ましいので、フォーカス群としてはレンズ枚数が少なくレンズ径の小さい第４レンズ群（Ｇｒ４）が好ましい。

【００３８】

また、各実施の形態のように、第２レンズ群（Ｇｒ２）中に非球面を配置することが望ま

しく、第２レンズ群中（Ｇｒ２）に非球面を配置することによって、像面湾曲収差を良好に補正することができる。また、各実施の形態のように、第４レンズ群（Ｇｒ４）中に非球面を配置することが望ましく、第４レンズ群中（Ｇｒ４）に非球面を配置することによって、像面湾曲収差や球面収差等さまざまな収差を良好に補正することができる。さらに、第５レンズ群（Ｇｒ５）中に非球面を配置することが望ましく、第５レンズ群中（Ｇｒ５）に非球面を配置することによって、さらに、像面湾曲収差を良好に補正することができる。

【００３９】

なお、第１～第４の実施の形態を構成している各レンズ群は、入射光線を屈折により偏向させる屈折型レンズ（つまり、異なる屈折率を有する媒質同士の界面で偏向が行われるタイプのレンズ）のみで構成されているが、これに限らない。例えば、回折により入射光線を偏向させる回折型レンズ、回折作用と屈折作用との組み合わせで入射光線を偏向させる屈折・回折ハイブリッド型レンズ、入射光線を媒質内の屈折率分布により偏向させる屈折率分布型レンズ等で、各レンズ群を構成してもよい。

【００４０】

さらに、各実施の形態ではズームレンズ系の最終面と撮像素子との間に配置される平行平面板形状の光学的ローパスフィルタの構成例を示したが、このローパスフィルタとしては、所定の結晶軸方向が調整された水晶等を材料とする複屈折型ローパスフィルタや、必要とされる光学的な遮断周波数の特性を回折効果により達成する位相型ローパスフィルタ等が適用可能である。

【００４１】

【実施例】

以下、本発明を実施した撮像レンズ装置に用いられるズームレンズ系の構成等を、コンストラクションデータ等を挙げて、更に具体的に説明する。なお、以下に挙げる実施例１～４は、前述した第１～第４の実施の形態にそれぞれ対応しており、第１～第４の実施の形態を表すレンズ構成図（図２～図５）は、対応する実施例１～４のレンズ構成をそれぞれ示している。

【００４２】

各実施例のコンストラクションデータにおいて、ｒｉ（ｉ＝１，２，３，．．．）は物体側から数えてｉ番目の面の曲率半径、ｄｉ（ｉ＝１，２，３，．．．）は物体側から数えてｉ番目の軸上面間隔を示しており、Ｎｉ（ｉ＝１，２，３，．．．），νｉ（ｉ＝１，２，３，．．．）は物体側から数えてｉ番目の光学要素のｄ線に対する屈折率（Ｎｄ），アッベ数（νｄ）をそれぞれ示している。また、コンストラクションデータ中、ズーミングにおいて変化する軸上面間隔は、広角端（短焦点距離端）［Ｗ］～ミドル（中間焦点距離状態）［Ｍ］～望遠端（長焦点距離端）［Ｔ］での可変空気間隔である。各焦点距離状態［Ｗ］，［Ｍ］，［Ｔ］に対応する全系の焦点距離（ｆ）及びＦナンバー（ＦＮＯ）を併せて示し、また、条件式対応値を表１に示す。また、近接撮影時のフォーカシングにおける第４レンズ群（Ｇｒ４）の移動量（フォーカスデータ）を表２に示す。実施例１～３においては近接撮影状態の撮影距離（物点～像点）Ｄ＝０．３７ｍであり、実施例４は近接撮影状態の撮影距離（物点～像点）Ｄ＝０．６７ｍである。

【００４３】

曲率半径ｒｉに＊印が付された面は、非球面で構成された面であることを示し、非球面の面形状を表わす以下の式（ＡＳ）で定義されるものとする。各非球面の非球面データを他のデータと併せて示す。

$$X(H)=(C\cdot H^2)/\{1+\sqrt{(1-\varepsilon\cdot C^2\cdot H^2)}\}+(A4\cdot H^4+A6\cdot H^6+A8\cdot H^8+A10\cdot H^{10}) \qquad (AS)$$

ただし、式（ＡＳ）中、

$X(H)$　：高さＨの位置での光軸方向の変位量（面頂点基準）、

Ｈ　：光軸に対して垂直な方向の高さ、

Ｃ　：近軸曲率、

ε　　：２次曲面パラメータ、
Ａｉ　　：ｉ次の非球面係数、
である。
【００４４】
図６〜図１３は実施例１〜実施例４にそれぞれ対応する収差図であり、図６〜図９は実施例１〜実施例４にそれぞれ対応する無限遠撮影状態での収差図、図１０〜図１３は実施例１〜実施例４にそれぞれ対応する近接撮影状態での収差図である。実施例１〜３においては近接撮影状態の撮影距離（物点〜像点）Ｄ＝０．３７ｍであり、実施例４は近接撮影状態の撮影距離（物点〜像点）Ｄ＝０．６７ｍである。図６〜図１３中、［Ｗ］は広角端，［Ｍ］はミドル，［Ｔ］は望遠端における諸収差（左から順に、球面収差等，非点収差，歪曲収差である。Ｙ’：最大像高）を示している。球面収差図において、実線（ｄ）はｄ線に対する球面収差、一点鎖線（ｇ）はｇ線に対する球面収差、二点鎖線（ｃ）はｃ線に対する球面収差、破線（ＳＣ）は正弦条件を表している。非点収差図において、破線（ＤＭ）はメリディオナル面でのｄ線に対する非点収差を表しており、実線（ＤＳ）はサジタル面でのｄ線に対する非点収差を表わしている。また、歪曲収差図において実線はｄ線に対する歪曲％を表している。
【００４５】

《実施例１》

f=5.00～15.00～24.00, FNO=3.40～3.25～3.26

[曲率半径]	[軸上面間隔]	[屈折率]	[アッベ数]
r1= 118.726			
	d1= 0.850	N1= 1.84666	ν1= 23.82
r2= 15.576			
	d2= 2.058		
r3= ∞			
	d3= 11.500	N2= 1.84666	ν2= 23.78
r4= ∞			
	d4= 0.100		
r5= 33.443			
	d5= 3.000	N3= 1.62041	ν3= 60.29
r6= -27.845			
	d6= 0.100		
r7= 19.290			
	d7= 2.500	N4= 1.63854	ν4= 55.62
r8= 569.934			
	d8= 0.740～10.098～12.849		
r9*= -72.357			
	d9= 0.800	N5= 1.52200	ν5= 52.20
r10*= 6.402			
	d10= 2.055		
r11= -5.258			
	d11= 0.750	N6= 1.75450	ν6= 51.57
r12= 29.887			
	d12= 1.710	N7= 1.84666	ν7= 23.82
r13= -13.462			
	d13= 13.079～3.722～0.970		

r14= ∞ (SP)

d14= 0.430

r15= 15.966

d15= 1.500 N8= 1.80610 ν8= 40.72

r16= -172.905

d16= 6.573

r17= 12.407

d17= 2.904 N9= 1.48749 ν9= 70.44

r18= -8.734

d18= 0.850 N10=1.84666 ν10=23.82

r19= -60.848

d19= 5.906～2.050～3.216

r20*= 7.586

d20= 0.950 N11=1.84506 ν11=23.66

r21= 5.428

d21= 1.000

r22= 6.987

d22= 2.600 N12=1.53172 ν12=48.84

r23= -39.112

d23= 3.525～7.381～6.215

r24*= -24.125

d24= 1.500 N13= 1.52510 ν13=56.38

r25*= -49.443

d25= 0.629

r26= ∞

d26= 1.300 N14= 1.51680 ν14= 64.20

r27= ∞

d27= 0.600

r28= ∞

d28= 0.700 N14= 1.51680 ν14= 64.20

r29= ∞

[第９面(r9)の非球面データ]

ε = 1.00000

A4= 0.13728318×10^{-2}

A6=-0.13493699×10^{-4}

A8= 0.47509623×10^{-6}

[第１０面(r10)の非球面データ]

ε = 1.00000

A4= 0.11265340×10^{-2}

A6= 0.15685648×10^{-4}

A8= 0.40463823×10^{-5}

[第２０面(r20)の非球面データ]

ε = 1.00000

A4= 0.48807721×10^{-4}

A6= 0.14566395×10^{-5}

A8= 0.20689300×10^{-6}

[第２４面(r24)の非球面データ]

ε = 1.00000

A4=-0.96805708×10^{-3}

A6= 0.17138459×10^{-3}

A8=-0.13824254×10^{-4}

[第２５面(r25)の非球面データ]

ε = 1.00000

A4=-0.59943279×10^{-3}

A6= 0.18792404×10^{-3}

A8=-0.16040459×10^{-4}

【００４６】

《実施例２》

f=5.00～15.00～24.00, FNO=3.40～3.24～3.24

[曲率半径]	[軸上面間隔]	[屈折率]	[アッベ数]
r1= 133.325			
	d1= 0.850	N1= 1.84666	ν1= 23.82
r2= 15.888			
	d2= 2.025		
r3= ∞			
	d3= 11.600	N2= 1.84666	ν2= 23.82
r4= ∞			
	d4= 0.100		
r5= 35.391			
	d5= 3.035	N3= 1.63854	ν3= 55.62
r6= −26.543			
	d6= 0.100		
r7= 16.974			
	d7= 2.515	N4= 1.58913	ν4= 61.11
r8= 151.530			
	d8= 0.740～10.019～12.717		
r9*= −38.770			
	d9= 0.800	N5= 1.52200	ν5= 52.20
r10*= 6.550			
	d10= 2.062		
r11= −4.749			
	d11= 0.750	N6= 1.75450	ν6= 51.57
r12= 73.988			
	d12= 1.710	N7= 1.84666	ν7= 23.82
r13= −11.055			
	d13= 12.947～3.669～0.970		

r14= ∞ (SP)

d14= 0.430

r15= 16.559

d15= 1.509 N8= 1.78831 ν8= 47.32

r16= -74.508

d16= 6.564

r17= 12.712

d17= 2.956 N9= 1.48749 ν9= 70.44

r18= -8.644

d18= 0.850 N10=1.84666 ν10=23.82

r19= -45.947

d19= 7.220〜2.057〜3.601

r20*= 7.626

d20= 0.950 N11=1.84506 ν11=23.66

r21= 5.238

d21= 1.000

r22= 6.734

d22= 2.366 N12=1.58267 ν12=46.43

r23= 185.136

d23= 2.047〜7.210〜5.665

r24*= -23.000

d24= 2.000 N13= 1.52510 ν13=56.38

r25*= -16.473

d25= 0.450

r26= ∞

d26= 1.300 N14= 1.51680 ν14= 64.20

r27= ∞

d27= 0.600

r28= ∞

$d28= 0.700$ $N14= 1.51680$ $\nu14= 64.20$

$r29= \infty$

[第９面(r9)の非球面データ]

$\varepsilon = 1.00000$

$A4= 0.18640680\times10^{-2}$

$A6=-0.41315515\times10^{-4}$

$A8= 0.15957856\times10^{-5}$

[第１０面(r10)の非球面データ]

$\varepsilon = 1.00000$

$A4= 0.15462609\times10^{-2}$

$A6=-0.10995458\times10^{-4}$

$A8= 0.54077447\times10^{-5}$

[第２０面(r20)の非球面データ]

$\varepsilon = 1.00000$

$A4= 0.91946129\times10^{-4}$

$A6= 0.23183290\times10^{-5}$

$A8= 0.23697079\times10^{-6}$

[第２４面(r24)の非球面データ]

$\varepsilon = 1.00000$

$A4=-0.84583166\times10^{-3}$

$A6= 0.75642550\times10^{-4}$

$A8=-0.76037481\times10^{-5}$

[第２５面(r25)の非球面データ]

$\varepsilon = 1.00000$

$A4=-0.30595350\times10^{-3}$

$A6= 0.55919456\times10^{-4}$

$A8=-0.67864381\times10^{-5}$

【００４７】

《実施例３》

f=5.00～15.00～24.00, FNO=3.40～3.35～3.35

[曲率半径]	[軸上面間隔]	[屈折率]	[アッベ数]
r1= 88.454			
	d1= 0.850	N1= 1.84666	ν1= 23.82
r2= 14.917			
	d2= 2.188		
r3= ∞			
	d3= 11.600	N2= 1.84666	ν2= 23.78
r4= ∞			
	d4= 0.100		
r5= 32.241			
	d5= 3.208	N3= 1.62280	ν3= 56.88
r6= -25.250			
	d6= 0.100		
r7= 18.784			
	d7= 2.400	N4= 1.58913	ν4= 61.11
r8= 164.159			
	d8= 0.740～10.218～13.125		
r9*= -28.564			
	d9= 0.800	N5= 1.5220	ν5= 52.20
r10*= 7.627			
	d10= 2.166		
r11= -4.799			
	d11= 0.750	N6= 1.75450	ν6= 51.57
r12= -335.530			
	d12= 1.710	N7= 1.84666	ν7= 23.82
r13= -10.446			
	d13= 13.355～3.877～0.970		

r14= ∞ (S P)

d14= 0.430

r15= 14.447

d15= 1.520 N8= 1.83400 ν8= 37.34

r16= 756.167

d16= 6.581

r17= 11.270

d17= 2.841 N9= 1.48749 ν9= 70.44

r18= -9.120

d18= 0.850 N10=1.84666 ν10=23.82

r19= 55.732

d19= 5.119～2.050～3.574

r20*= 8.963

d20= 0.950 N11=1.84506 ν11=23.66

r21= 6.451

d21= 0.943

r22= 8.132

d22= 3.188 N12=1.54072 ν12=47.20

r23= -16.953

d23= 4.994～8.062～6.539

r24= ∞

d26= 1.300 N14= 1.51680 V14= 64.20

r25= ∞

d27= 0.600

r26= ∞

d28= 0.700 N14= 1.51680 V14= 64.20

r27= ∞

[第９面(r9)の非球面データ]

ε= 1.00000

$A4= 0.20471287\times10^{-2}$

$A6=-0.52314206\times10^{-4}$

$A8= 0.18678759\times10^{-5}$

[第１０面(r10)の非球面データ]

$\varepsilon = 1.00000$

$A4= 0.16370282\times10^{-2}$

$A6=-0.77909254\times10^{-5}$

$A8= 0.32476408\times10^{-5}$

[第２０面(r20)の非球面データ]

$\varepsilon = 1.00000$

$A4=-0.10543001\times10^{-3}$

$A6= 0.28497046\times10^{-5}$

$A8=-0.17276234\times10^{-8}$

【００４８】

《実施例４》

f=5.00～15.01～24.00, FNO=3.40～3.23～3.22

[曲率半径]	[軸上面間隔]	[屈折率]	[アッベ数]
r1= 49.826			
	d1= 0.850	N1= 1.84666	ν1= 23.82
r2= 16.789			
	d2= 2.431		
r3= ∞			
	d3= 12.200	N2= 1.84666	ν2= 23.78
r4= ∞			
	d4= 0.100		
r5= 41.363			
	d5= 2.437	N3= 1.69100	ν3= 54.75
r6= -51.928			
	d6= 0.100		
r7= 21.081			
	d7= 2.948	N4= 1.51680	ν4= 64.20
r8= -68.150			
	d8= 0.740～11.309～14.348		
r9*= -20.505			
	d9= 0.800	N5= 1.52200	ν5= 52.20
r10*= 7.013			
	d10= 2.128		
r11= -5.877			
	d11= 0.750	N6= 1.75450	ν6= 51.57
r12= 37.049			
	d12= 2.350	N7= 1.84666	ν7= 23.82
r13= -13.312			
	d13= 15.246～4.677～1.638		

r14= ∞ (S P)

d14= 0.450

r15= 23.499

d15= 2.102 N8= 1.75690 ν8= 29.69

r16= -32.127

d16= 0.850

r17= 24.860

d17= 3.250 N9= 1.69100 ν9= 54.75

r18= -9.756

d18= 0.850 N10=1.84666 ν10=23.82

r19= 78.407

d19= 13.270～8.215～8.900

r20*= 8.311

d20= 0.950 N11=1.84506 ν11=23.66

r21= 5.915

d21= 0.868

r22= 7.193

d22= 2.993 N12=1.48749 ν12=70.44

r23= -28.312

d23= 1.495～6.550～5.865

r24*= 8.798

d24= 1.540 N13= 1.52510 ν13=56.38

r25*= 8.572

d25= 1.884

r26= ∞

d26= 1.300 N14= 1.51680 V14= 64.20

r27= ∞

d27= 0.600

r28= ∞

d28= 0.700 N14= 1.51680 ν14= 64.20

r29= ∞

[第９面(r9)の非球面データ]

ε = 1.00000

A4= 0.14751216×10^{-2}

A6= -0.38769554×10^{-4}

A8= 0.64244535×10^{-6}

[第１０面(r10)の非球面データ]

ε = 1.00000

A4= 0.11487033×10^{-2}

A6= -0.32301579×10^{-6}

A8= 0.68660388×10^{-6}

[第２０面(r20)の非球面データ]

ε = 1.00000

A4= 0.10913755×10^{-4}

A6= 0.34527941×10^{-5}

A8= 0.13104048×10^{-7}

[第２４面(r24)の非球面データ]

ε = 1.00000

A4= 0.90878003×10^{-3}

A6= -0.14873572×10^{-3}

A8= 0.14919137×10^{-5}

[第２５面(r25)の非球面データ]

ε = 1.00000

A4= 0.20691458×10^{-2}

A6= -0.33227828×10^{-3}

A8= 0.67156628×10^{-5}

【００４９】

【表１】

《条件式対応値》

	条件式(1) D2/fw	条件式(2) |fa1/fw|
実施例1	1.063	4.251
実施例2	1.058	4.275
実施例3	1.073	4.261
実施例4	2.34	6.053

【００５０】
【表２】

《フォーカスデータ》

フォーカス群：第4レンズ群(Gr4)			
移動方向：物体側			
撮影距離：実施例1～3 D＝0.37(m)、実施例4 D＝0.67(m)			
	フォーカス群の移動量(mm)		
	W	M	T
実施例1	0.096	0.668	1.692
実施例2	0.136	0.84	2.158
実施例3	0.087	0.7	1.753
実施例4	0.065	0.446	1.13

【００５１】
なお、第１～第４の実施の形態では、第１の反射部材に直角プリズムを、第２の反射部材に反射ミラーを使用しているが、反射部材はこれに限らない。例えば、第１の反射部材に反射ミラーを、第２の反射部材にプリズムを用いてもよく、反射ミラーは表面鏡でも裏面鏡でもよい。また反射部材は反射面に光学的パワーを持ってもよく、また反射型回折素子であってもよい。
【００５２】
また、第１～第４の実施の形態の撮像レンズ装置に対応する各デジタルカメラ１の構成は、図１で示した構成と同様であり、撮像レンズ装置以外に差異はない。
【００５３】
【発明の効果】
以上説明したように、本発明によれば、高画質を満足しつつ、ズームレンズ系の小型化、高変倍化を達成した撮像レンズ装置を実現することが出来る。特に、本発明の撮像レンズ

装置は、入射光軸を第１の反射面により光軸を略９０°折り曲げ、さらに第２の反射面により光軸を折り曲げているため、非常にコンパクトな撮像レンズ装置が実現できる。

【００５４】

また、本発明の撮像レンズ装置は、ズーミングにおいて、第１の反射面と絞りと第２の反射面とは位置固定で、第１の反射面と第２の反射面との間に配置された第１の移動レンズ群と、第２の反射面の像側に配置された第２の移動レンズ群とを移動させるため、鏡胴構成が簡略化でき、コンパクト化と低コスト化が可能となる。また、インナーズーム方式のため、撮影中にレンズが飛び出すことはない。

【００５５】

さらに、上記撮像レンズ装置をデジタルカメラ、ビデオカメラ、その他電子機器（例えば、パーソナルコンピュータ、モバイルコンピュータ、携帯電話、情報携帯端末等）に内蔵または外付けされるカメラに適用し、これらの機器のコンパクト化（薄型化）、高変倍率化および高画質化を図ることができる。

【図面の簡単な説明】

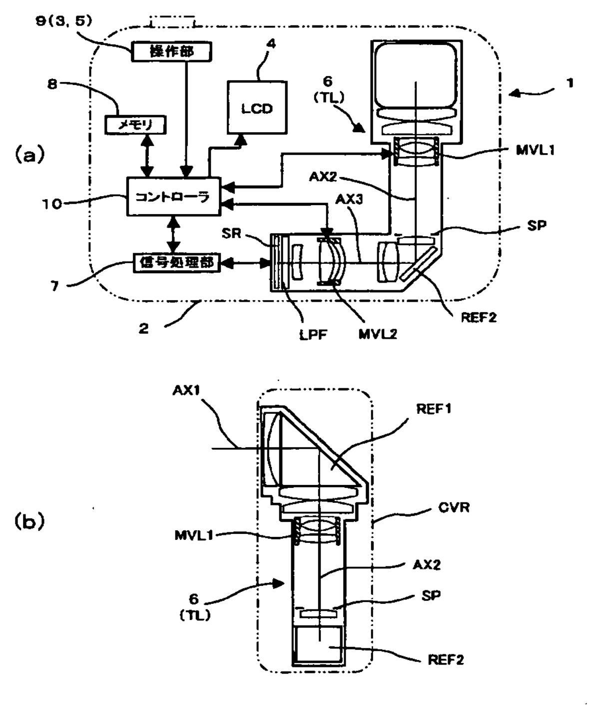
【図１】デジタルカメラの内部構成の概略を示す図である。
【図２】第１の実施の形態（実施例１）のレンズ構成図である。
【図３】第２の実施の形態（実施例２）のレンズ構成図である。
【図４】第３の実施の形態（実施例３）のレンズ構成図である。
【図５】第４の実施の形態（実施例４）のレンズ構成図である。
【図６】実施例１の無限遠撮影状態での収差図である。
【図７】実施例２の無限遠撮影状態での収差図である。
【図８】実施例３の無限遠撮影状態での収差図である。
【図９】実施例４の無限遠撮影状態での収差図である。
【図１０】実施例１の近接撮影状態（Ｄ＝０．３７ｍ）での収差図である。
【図１１】実施例２の近接撮影状態（Ｄ＝０．３７ｍ）での収差図である。
【図１２】実施例３の近接撮影状態（Ｄ＝０．３７ｍ）での収差図である。
【図１３】実施例４の近接撮影状態（Ｄ＝０．６７ｍ）での収差図である。
【図１４】本発明に係るデジタルカメラの概略外観図である。

【符号の説明】

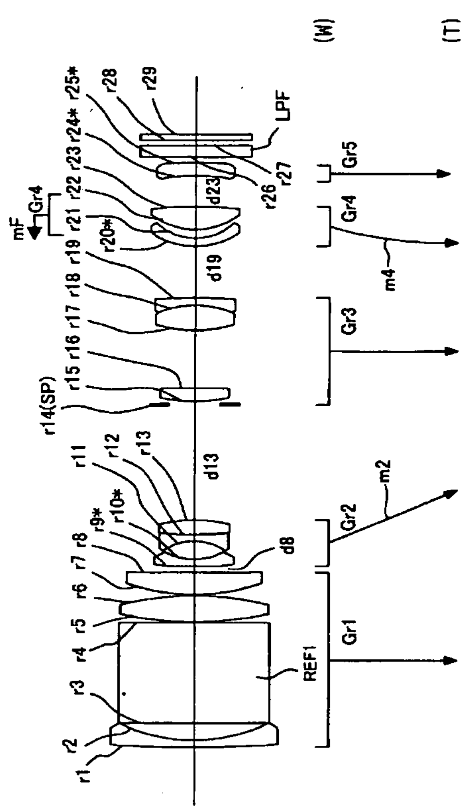
ＴＬ　撮像レンズ系（ズームレンズ系）
ＳＲ　撮像素子
ＬＰＦ　ローパスフィルタ（平行平面板）
ＡＸ１　第１の光軸（入射光軸）
ＡＸ２　第２の光軸
ＡＸ３　第３の光軸
ＲＥＦ１　第１の反射部材（直角プリズム）
ＲＥＦ２　第２の反射部材（反射ミラー）
ＭＶＬ１　第１の可動レンズ
ＭＶＬ２　第２の可動レンズ
ＣＶＲ　カメラの筐体
Ｇｒ１　第１レンズ群
Ｇｒ２　第２レンズ群
ＳＰ　絞り
Ｇｒ３　第３レンズ群
Ｇｒ４　第４レンズ群
Ｇｒ５　第５レンズ群
１　デジタルカメラ
２　筐体
３　レリーズボタン
４　液晶モニター（ＬＣＤ）

5　操作ボタン
6　撮像レンズ装置
7　信号処理部
8　メモリ
9　操作部
10　コントローラ

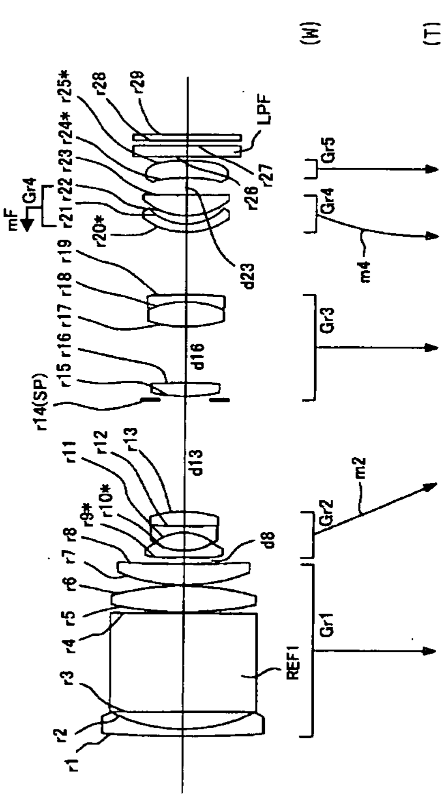
【図1】



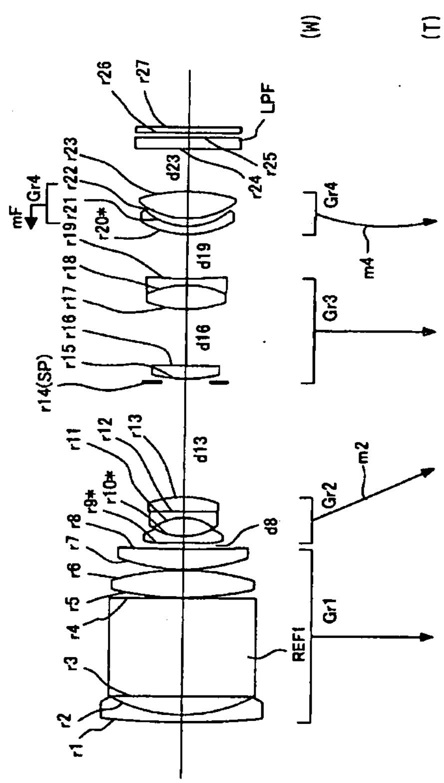
【図2】



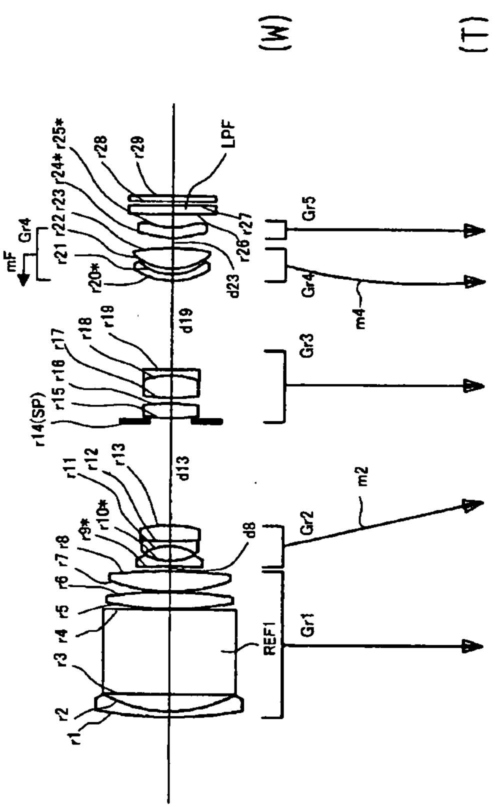
【図３】


(W)
(T)
r1
r2
r3
r4
r5
r6
r7
r8
r9*
r10*
r11
r12
r13
d8
d13
r14(SP)
r15
r16
r17
r18
r19
d16
r20*
r21
r22
r23
r24*
r25*
r26
r27
r28
r29
d23
LPF
REF1
mF
Gr1
Gr2
Gr3
Gr4
Gr5
m2
m4

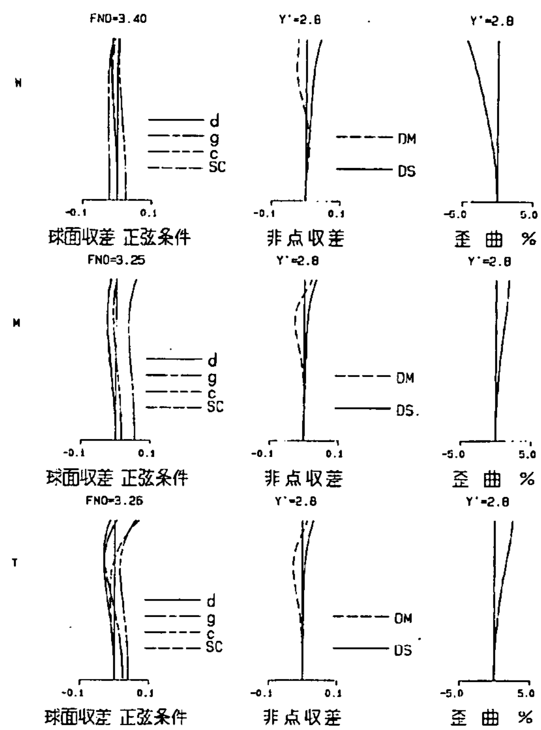
【図４】


(W)
(T)
r1
r2
r3
r4
r5
r6
r7
r8
r9*
r10*
r11
r12
r13
d8
d13
r14(SP)
r15
r16
r17
r18
r19
d16
d19
r20*
r21
r22
r23
r24
r25
r26
r27
d23
LPF
REF1
mF
Gr1
Gr2
Gr3
Gr4
m2
m4

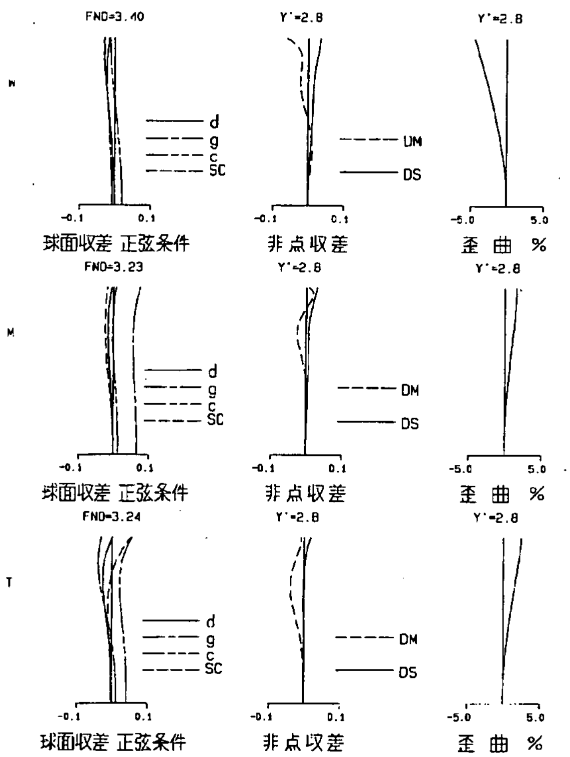
【図５】


(W)
(T)
r1
r2
r3
r4
r5
r6
r7
r8
r9*
r10*
r11
r12
r13
d8
d13
r14(SP)
r15
r16
r17
r18
r19
d19
r20*
r21
r22
r23
r24*
r25*
r26
r27
r28
r29
d23
LPF
REF1
mF
Gr1
Gr2
Gr3
Gr4
Gr5
m2
m4

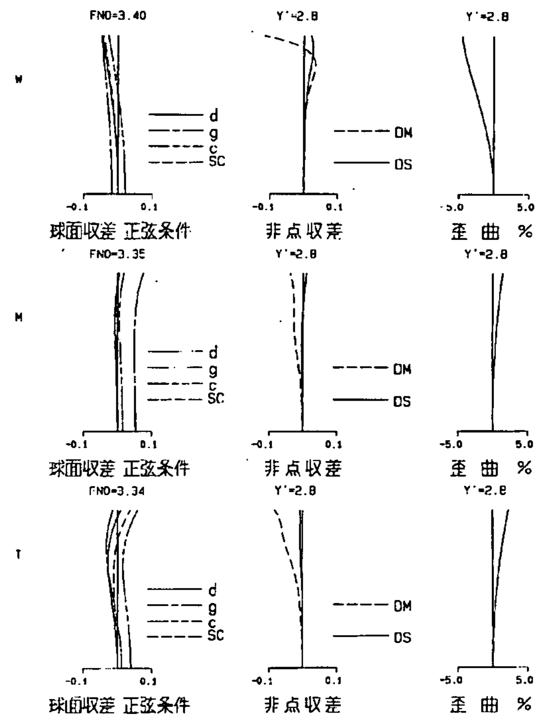
【図６】


FNO=3.40
Y'=2.8
Y'=2.8
W
d
g
c
SC
DM
DS
-0.1
0.1
-0.1
0.1
-5.0
5.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.25
Y'=2.8
Y'=2.8
M
d
g
c
SC
DM
DS.
-0.1
0.1
-0.1
0.1
-5.0
5.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.26
Y'=2.8
Y'=2.8
T
d
g
c
SC
DM
DS
-0.1
0.1
-0.1
0.1
-5.0
5.0
球面収差 正弦条件
非点収差
歪 曲 %

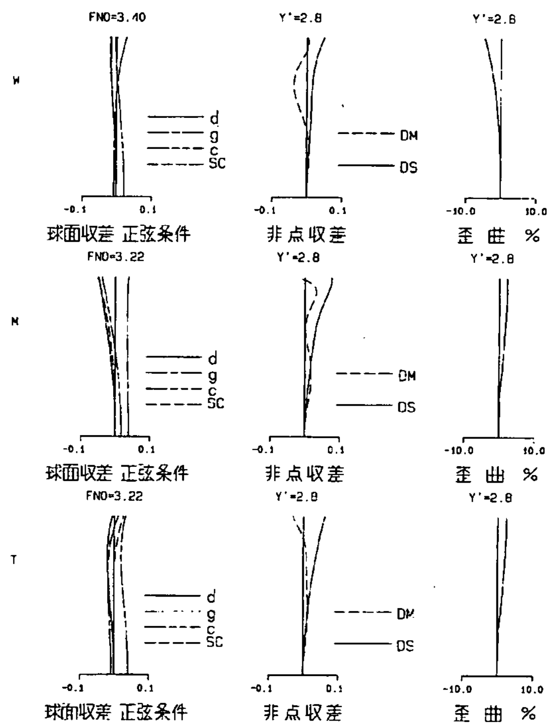
【図７】


W
M
T
FNO=3.40
FNO=3.23
FNO=3.24
Y'=2.8
d
g
c
SC
DM
DS
-0.1
0.1
-5.0
5.0
球面収差 正弦条件
非点収差
歪 曲 %

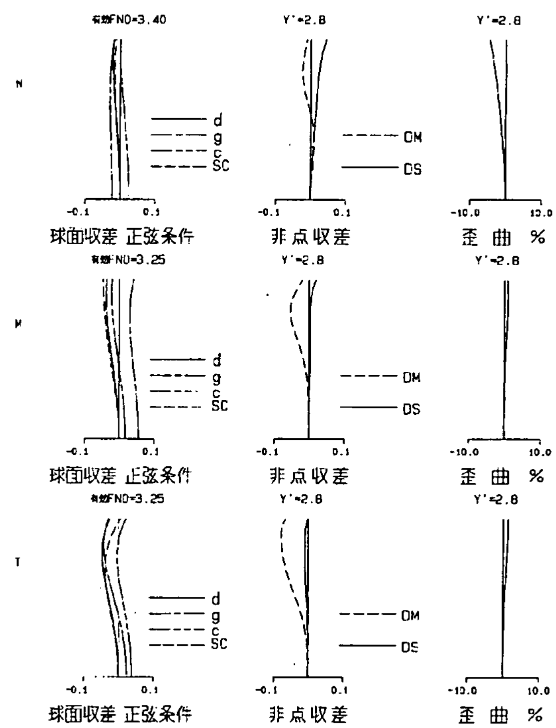
【図８】


W
M
T
FNO=3.40
FNO=3.35
FNO=3.34
Y'=2.8
d
g
c
SC
DM
DS
-0.1
0.1
-5.0
5.0
球面収差 正弦条件
非点収差
歪 曲 %

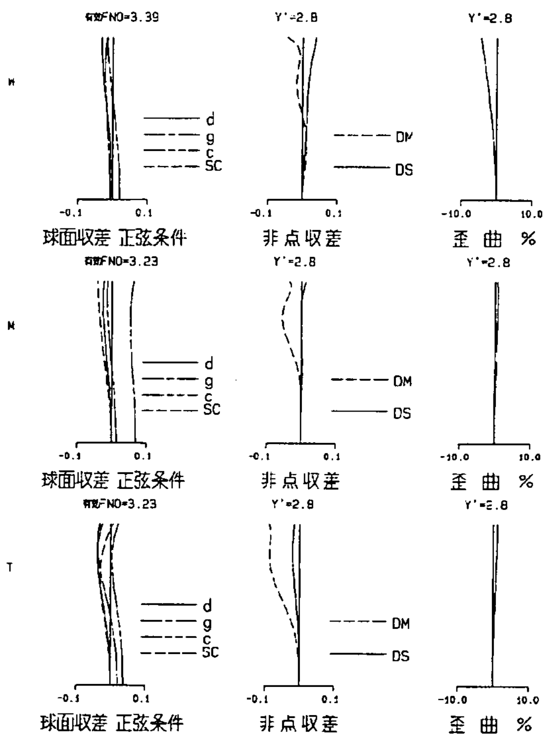
【図９】


W
M
T
FNO=3.40
FNO=3.22
FNO=3.22
Y'=2.8
d
g
c
SC
DM
DS
-0.1
0.1
-10.0
10.0
球面収差 正弦条件
非点収差
歪 曲 %

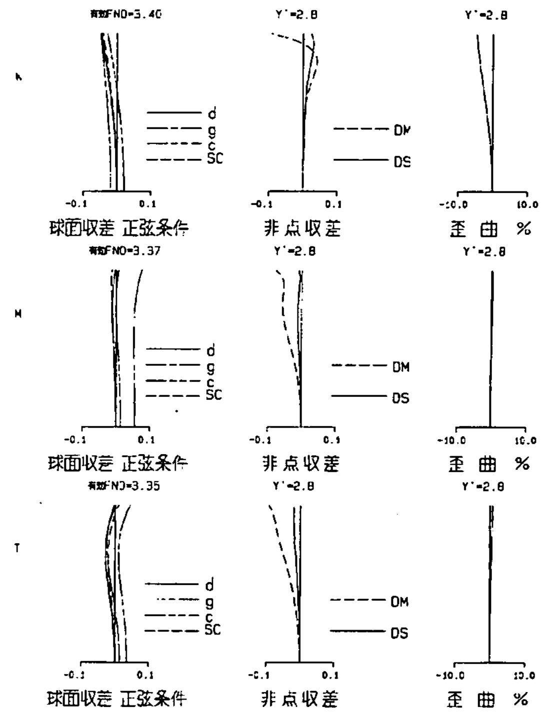
【図１０】


W
M
T
FNO=3.40
FNO=3.25
FNO=3.25
Y'=2.8
d
g
c
SC
DM
DS
-0.1
0.1
-10.0
10.0
球面収差 正弦条件
非点収差
歪 曲 %

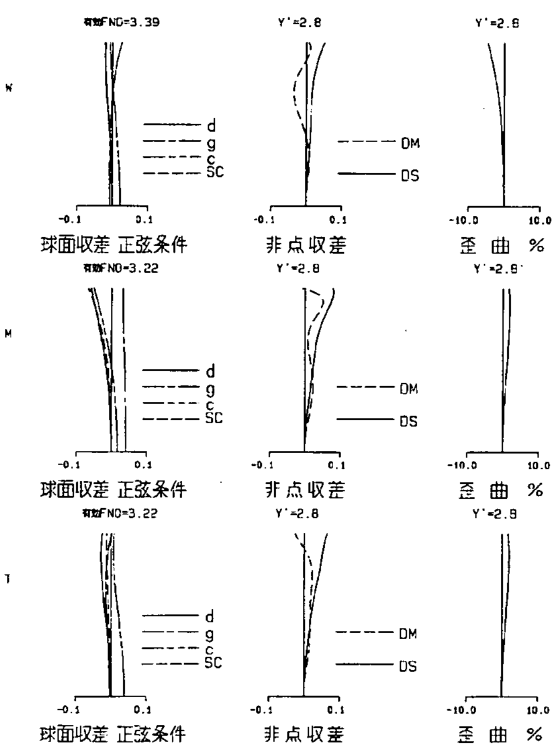
【図１１】



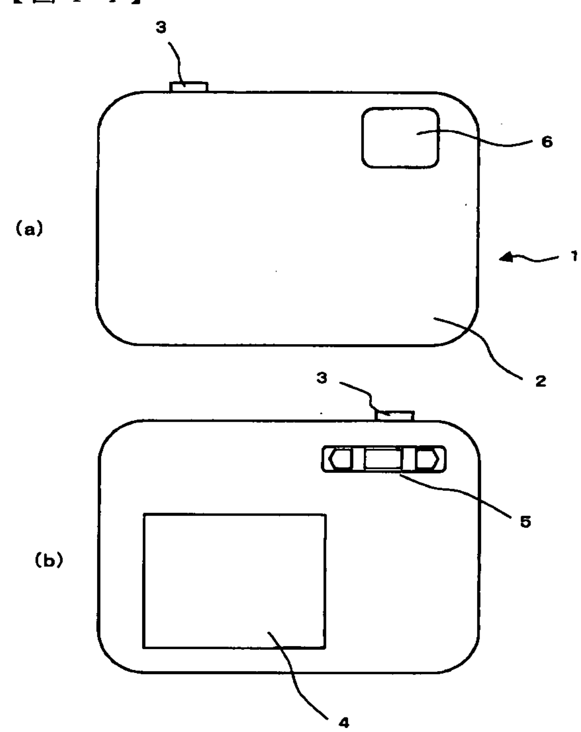
【図１２】



【図１３】



【図１４】



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SA23 SA27 SA29 SA32 SA43 SA47 SA49 SA52 SA55 SA56
SA63 SA65 SA72 SA74 SA76 SB04 SB14 SB24 SB33 SB42
TA04
2H101 FF00
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